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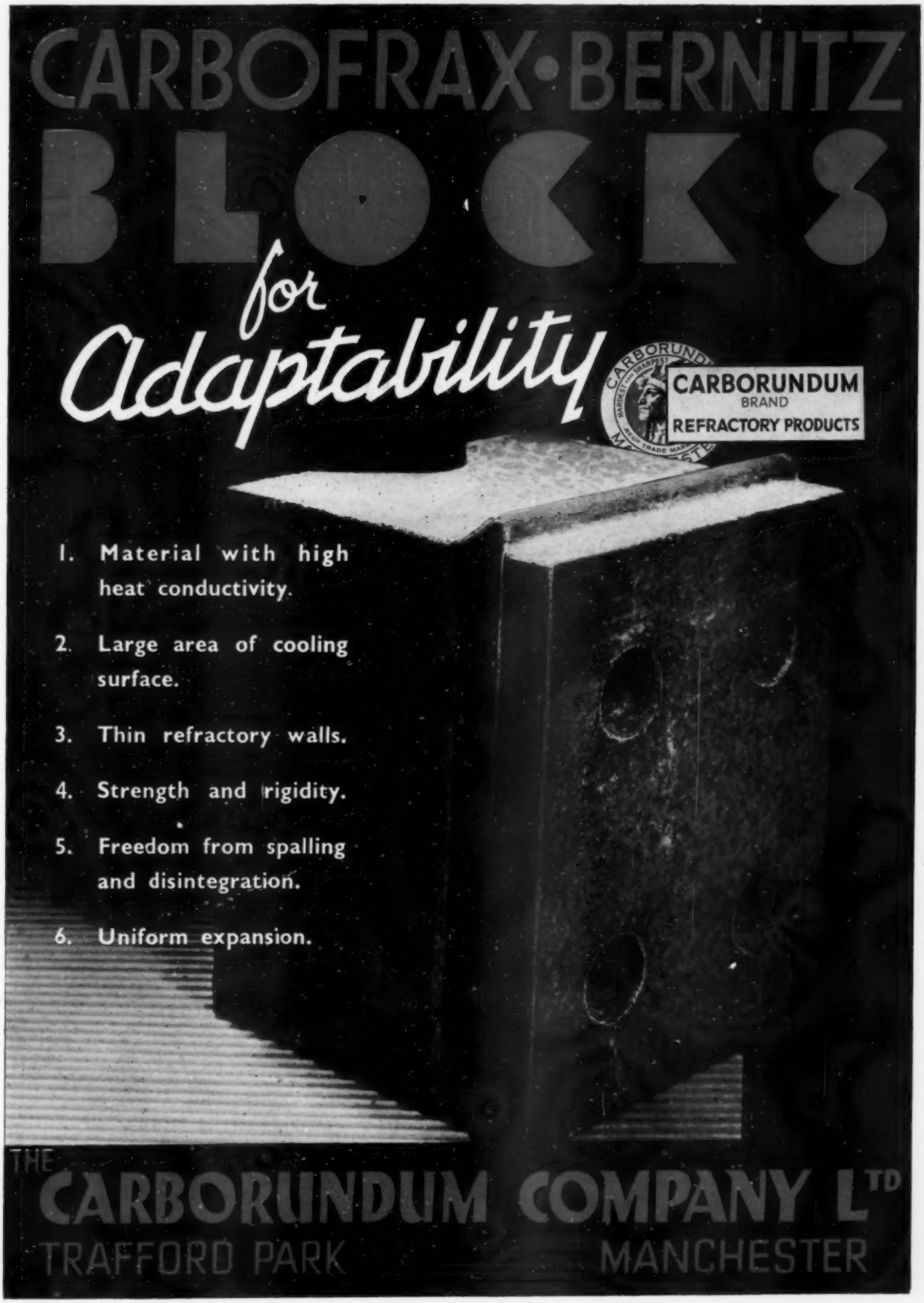
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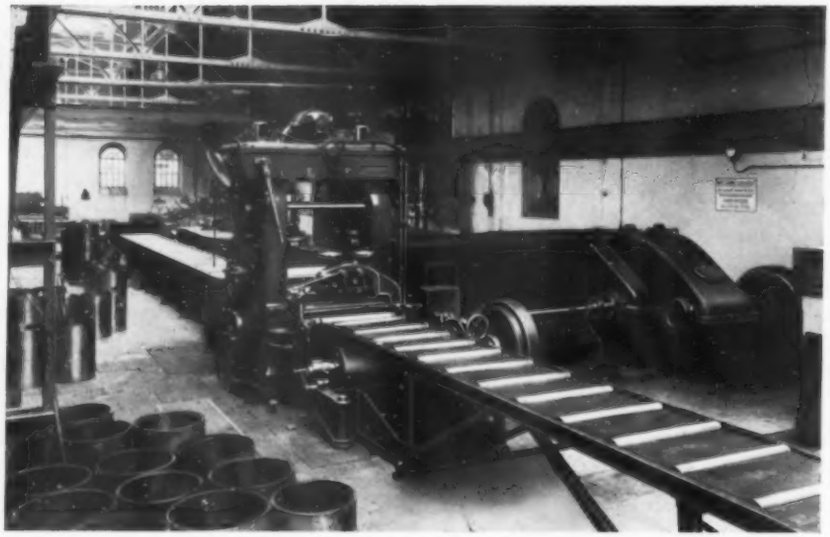

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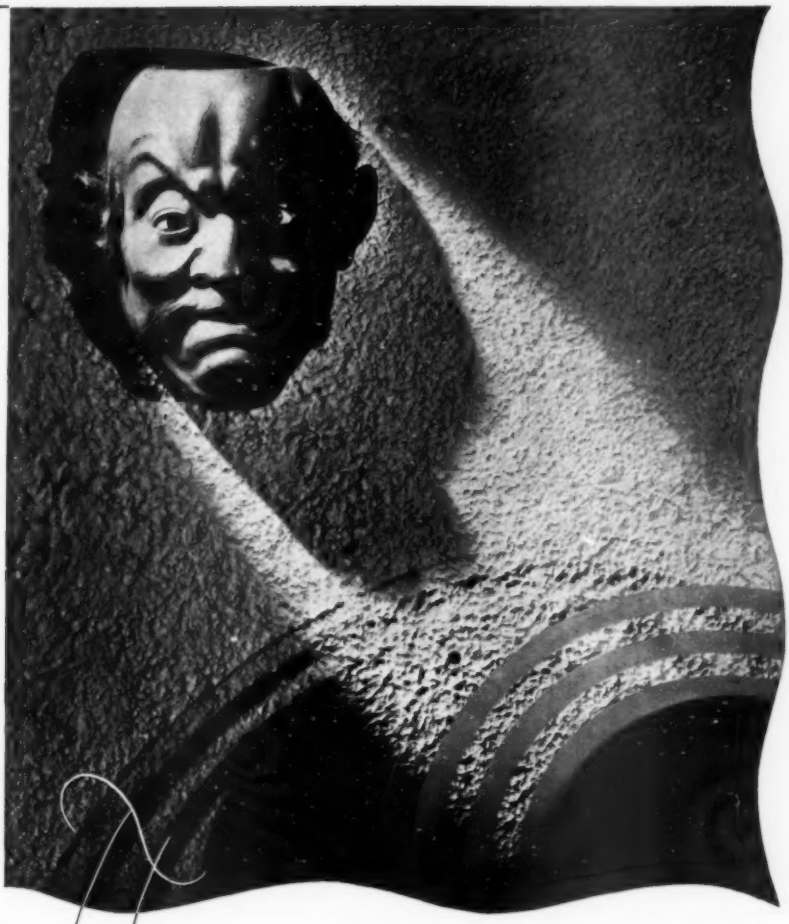

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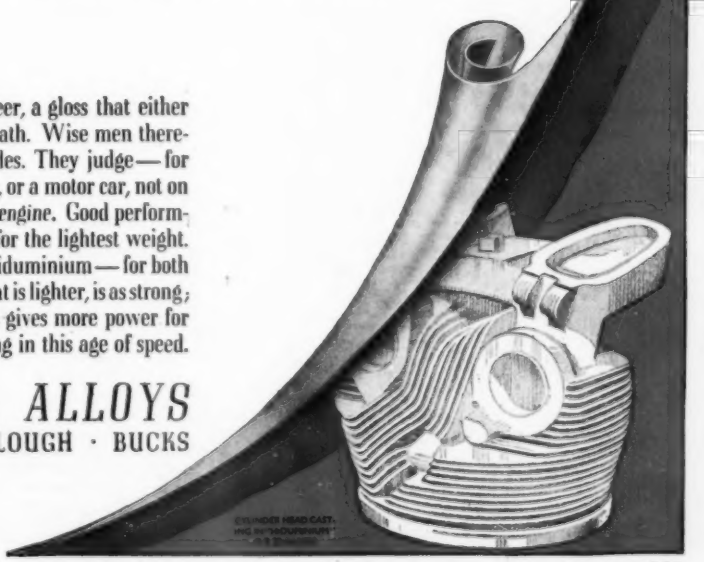

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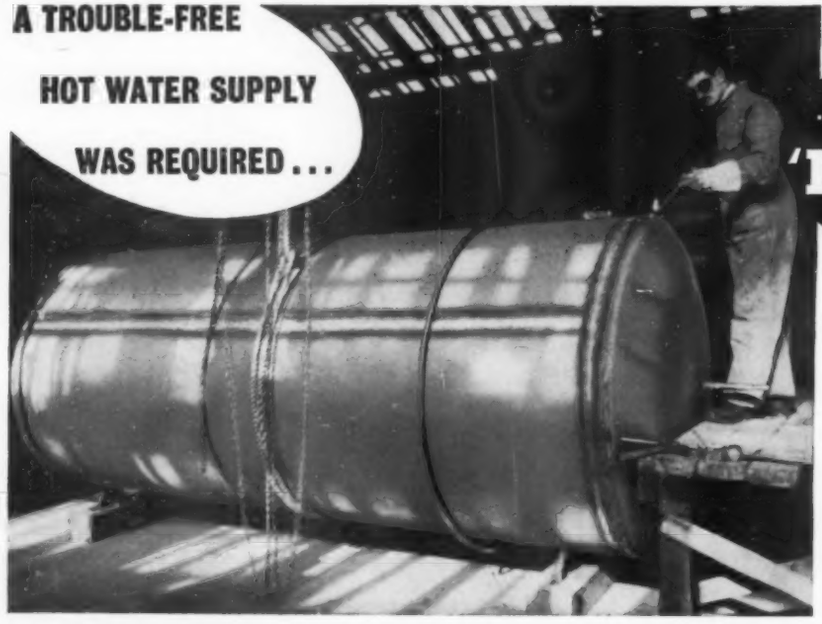

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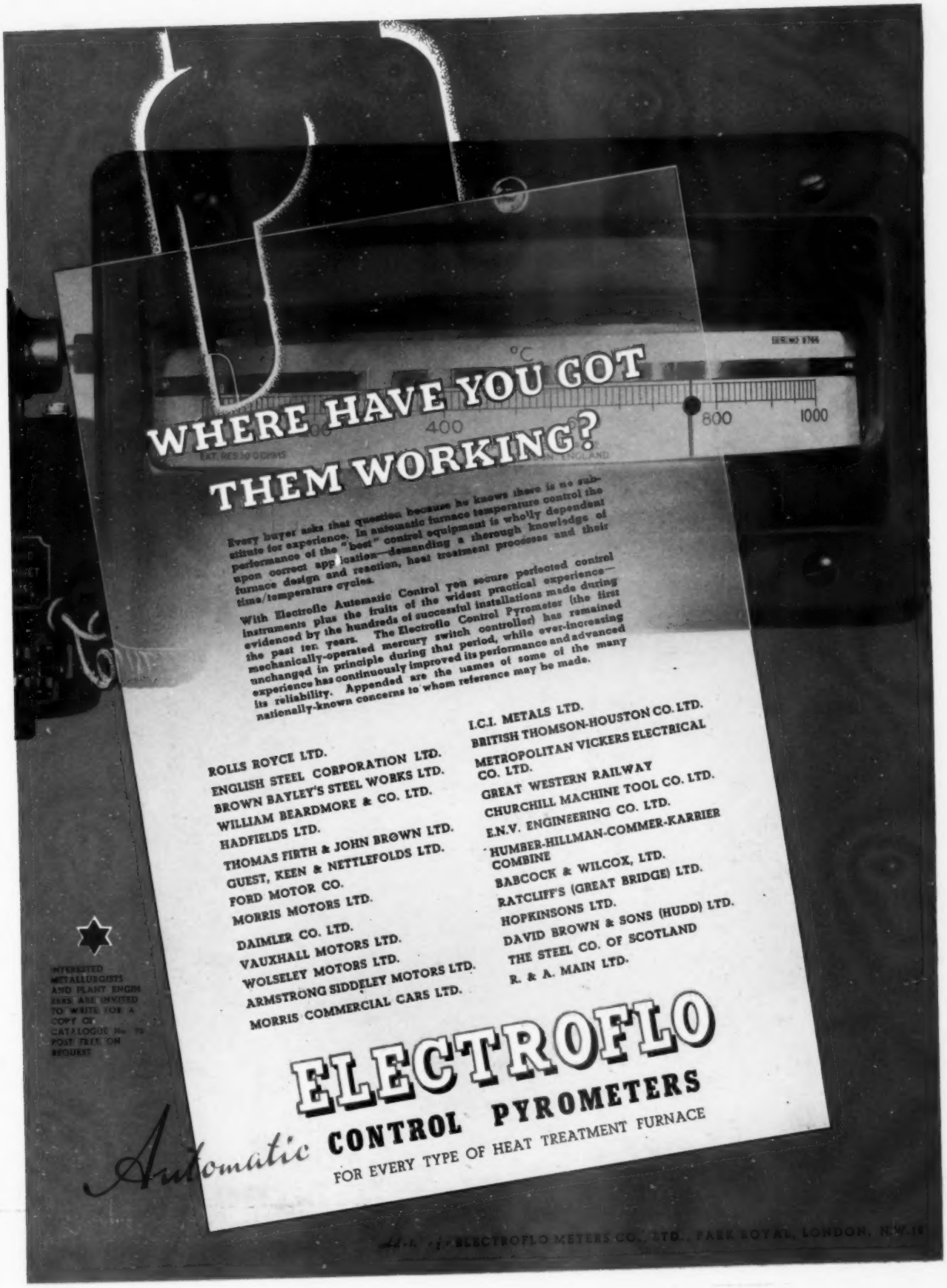
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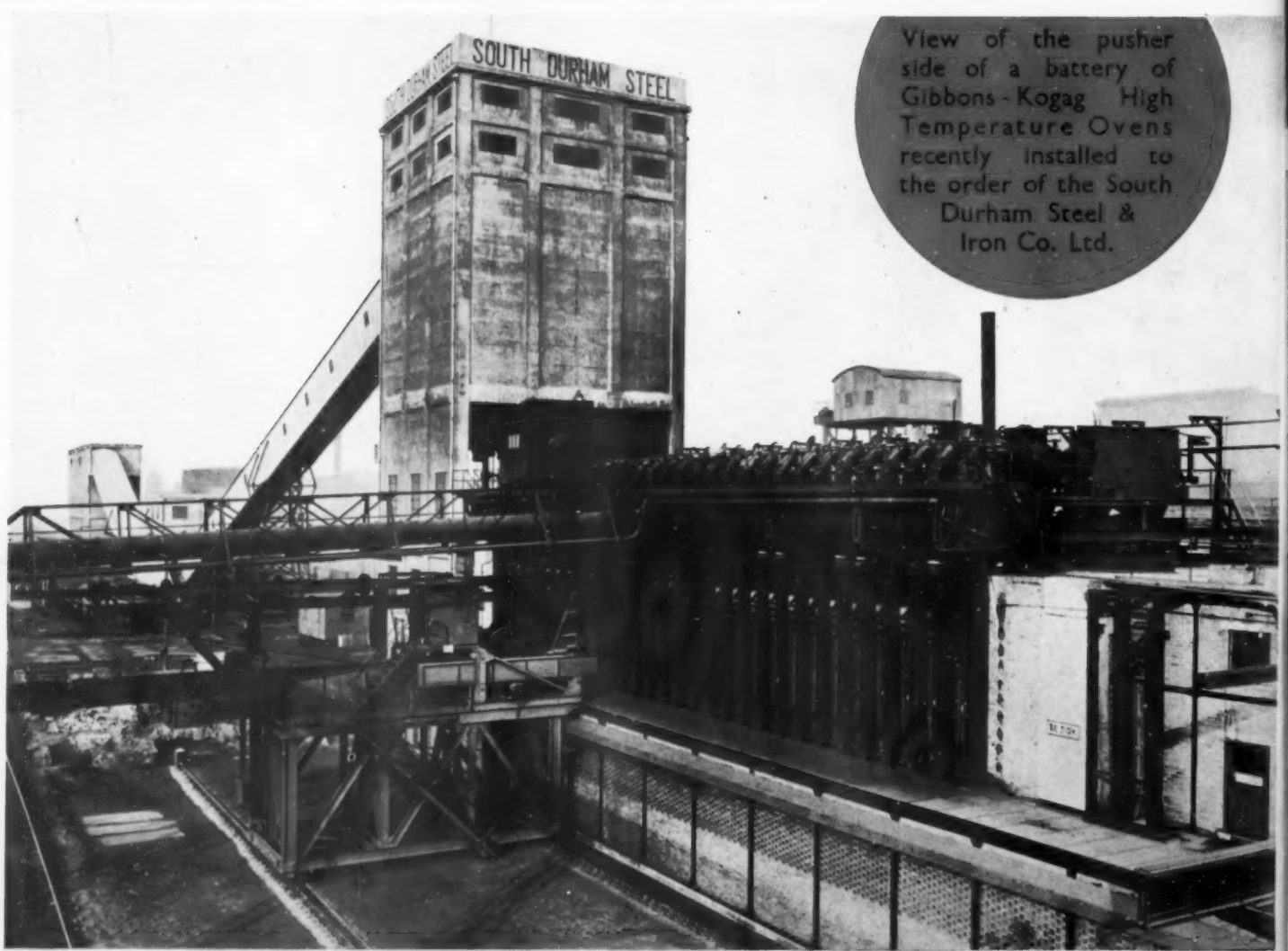

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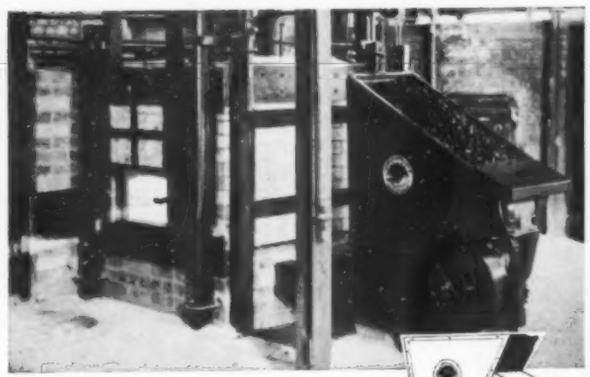

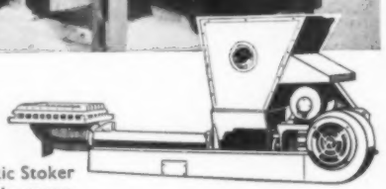

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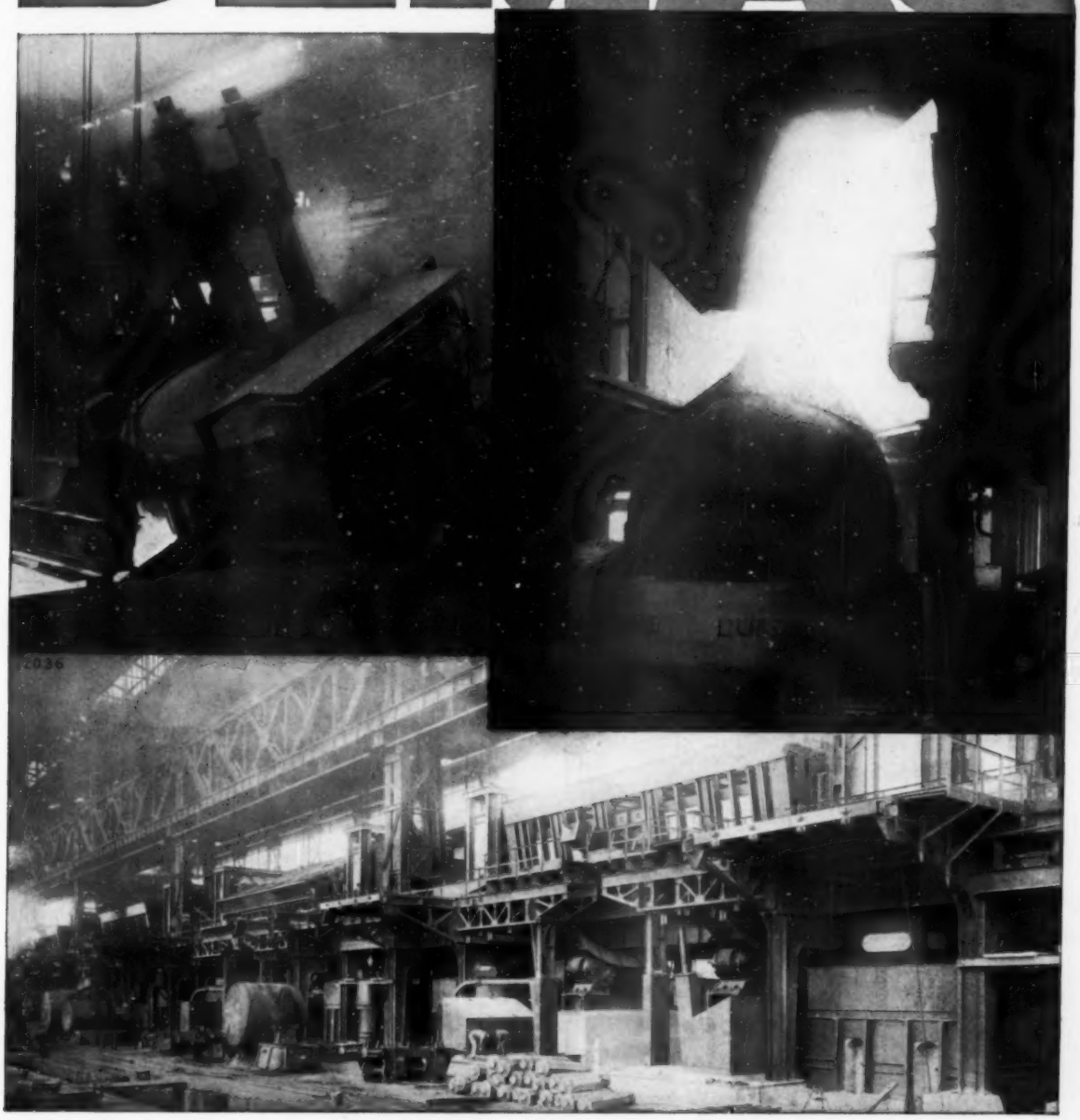

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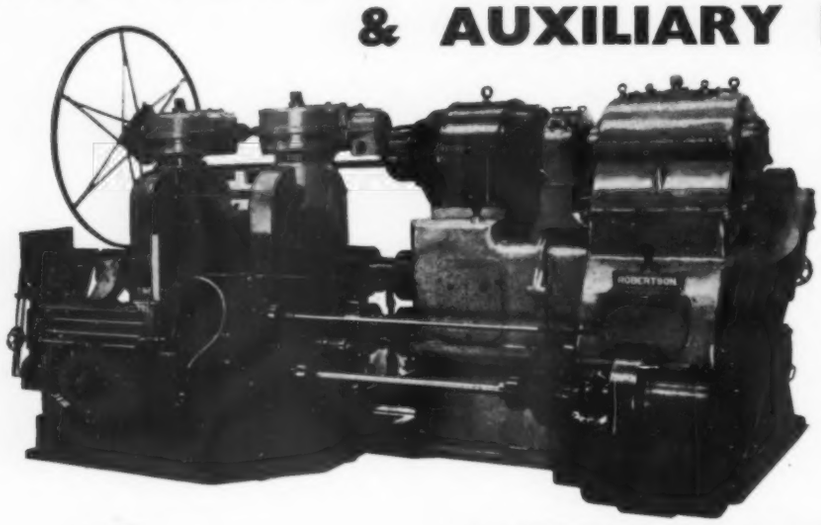

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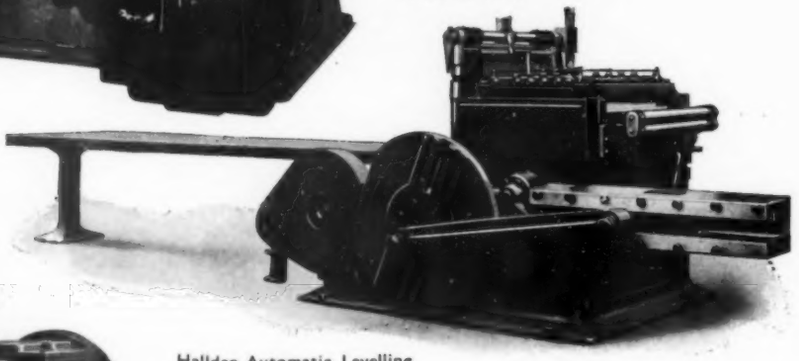

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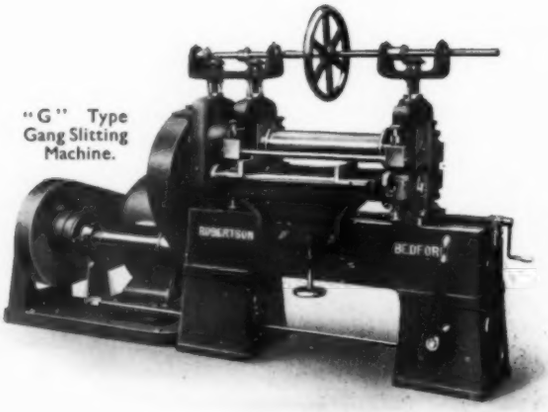

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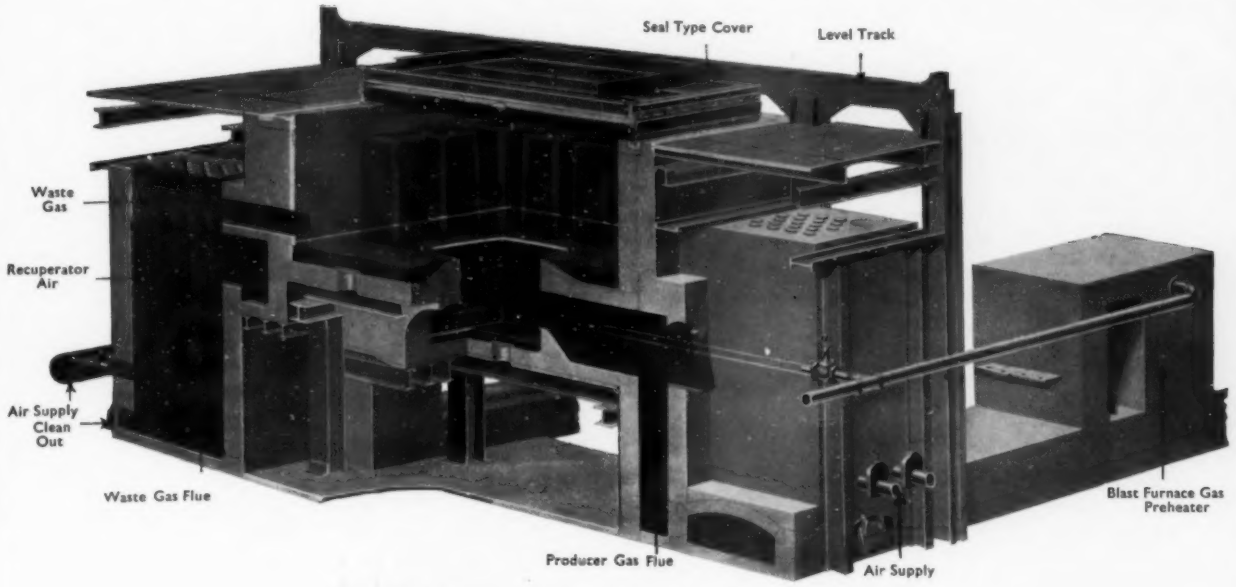

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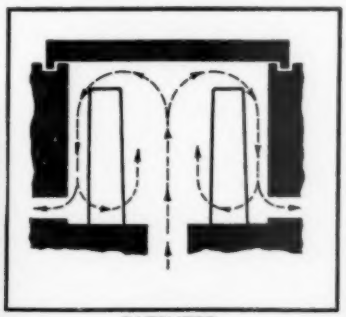

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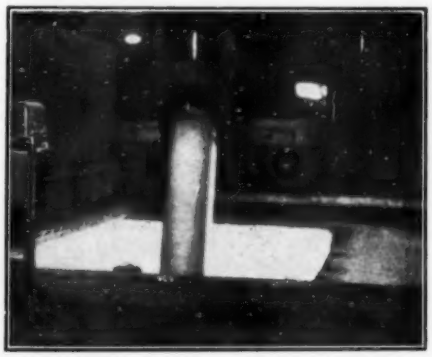

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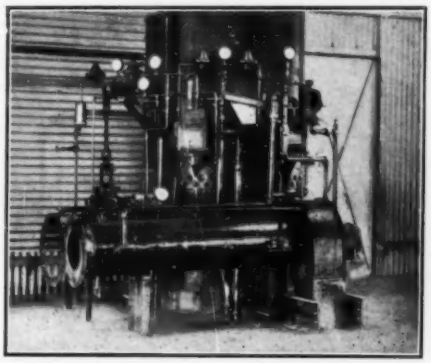

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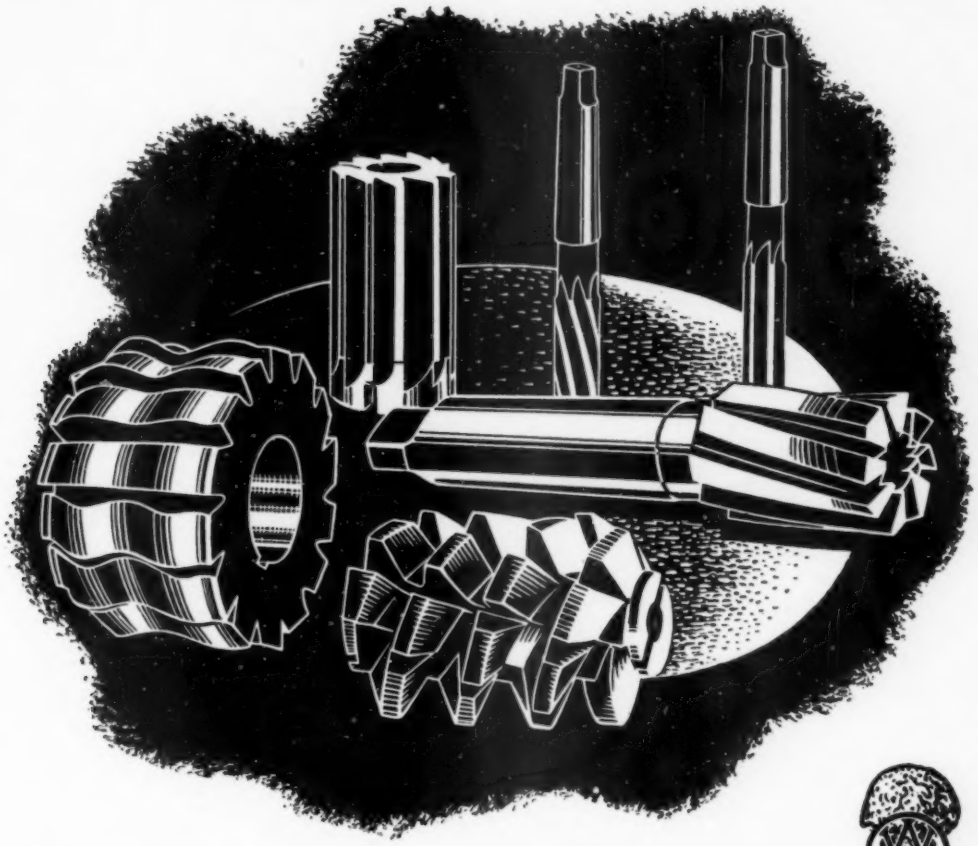

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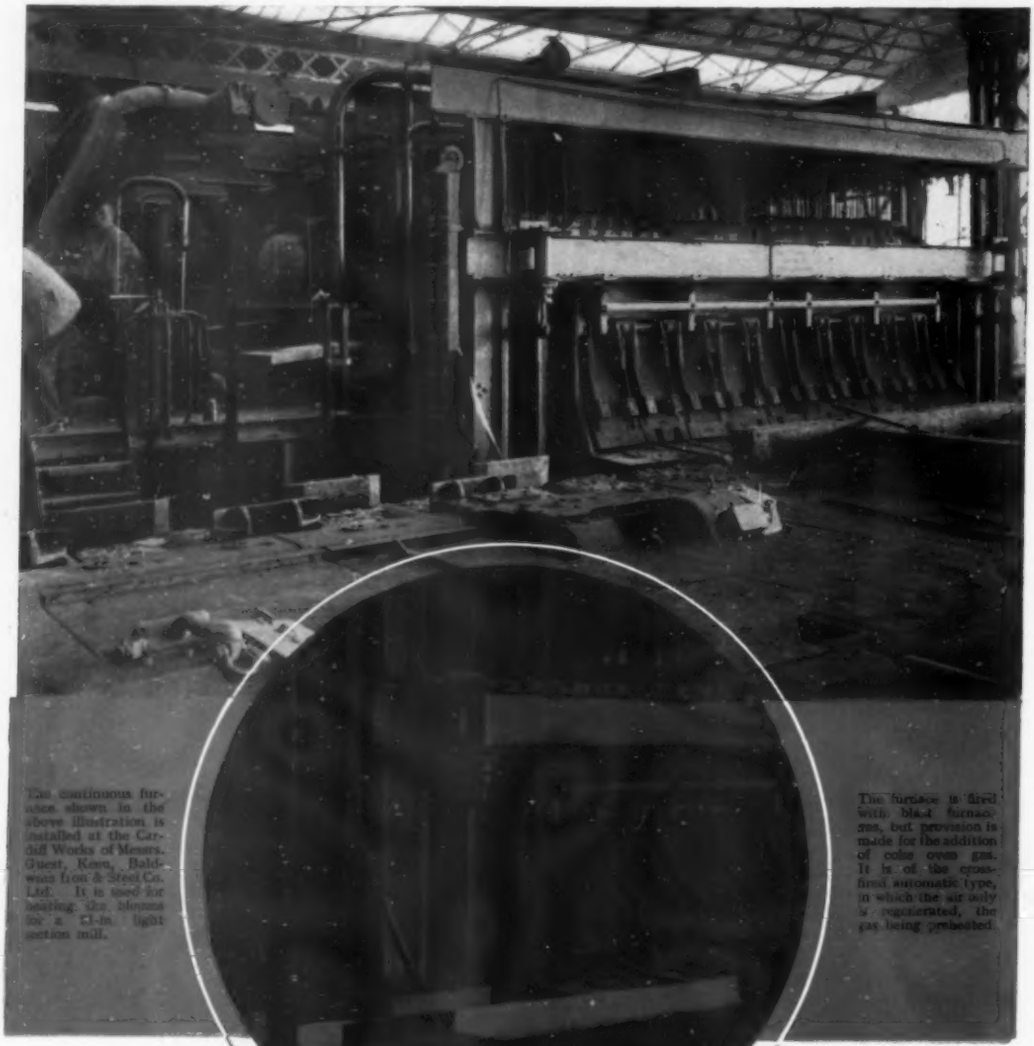

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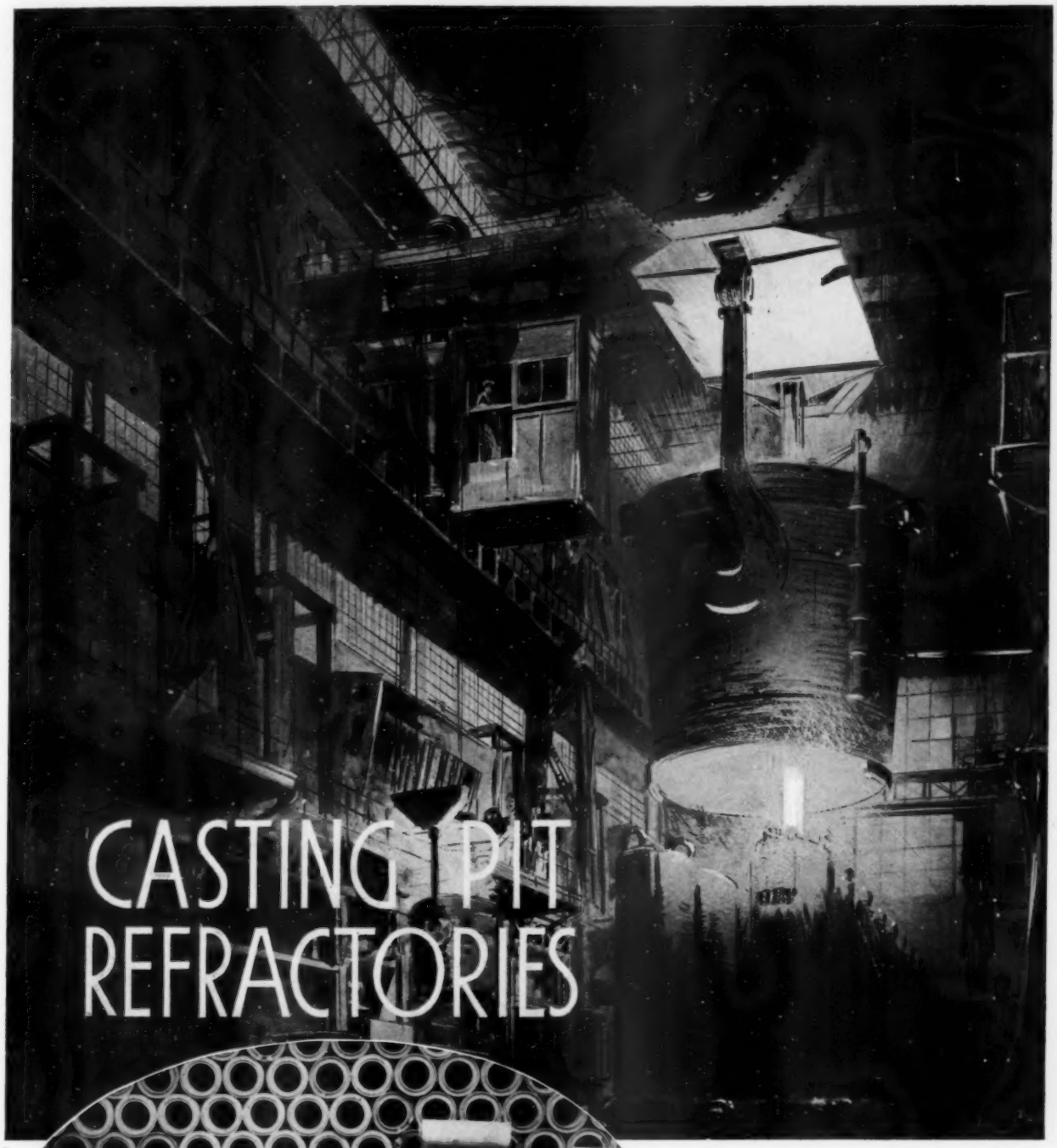

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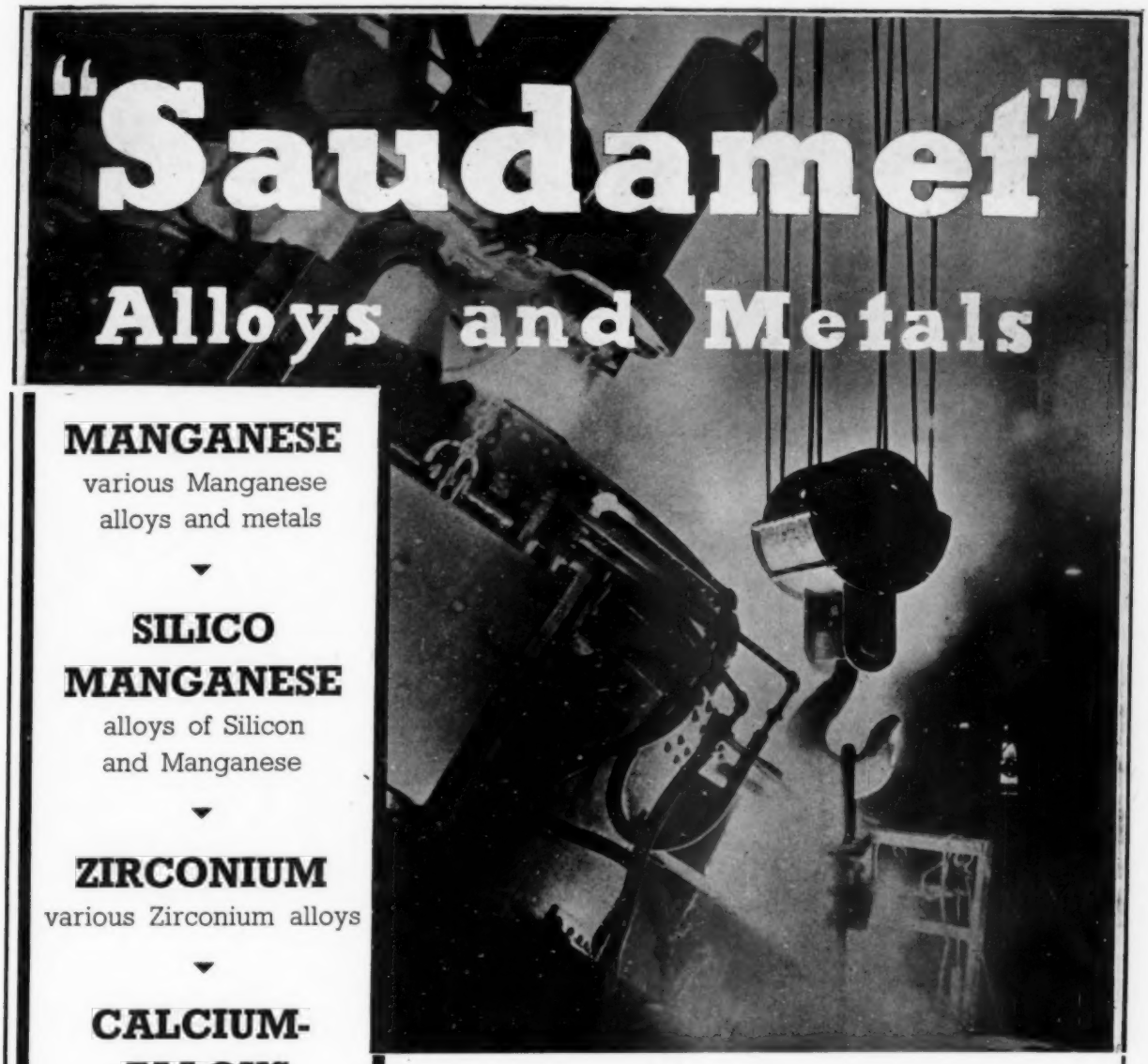

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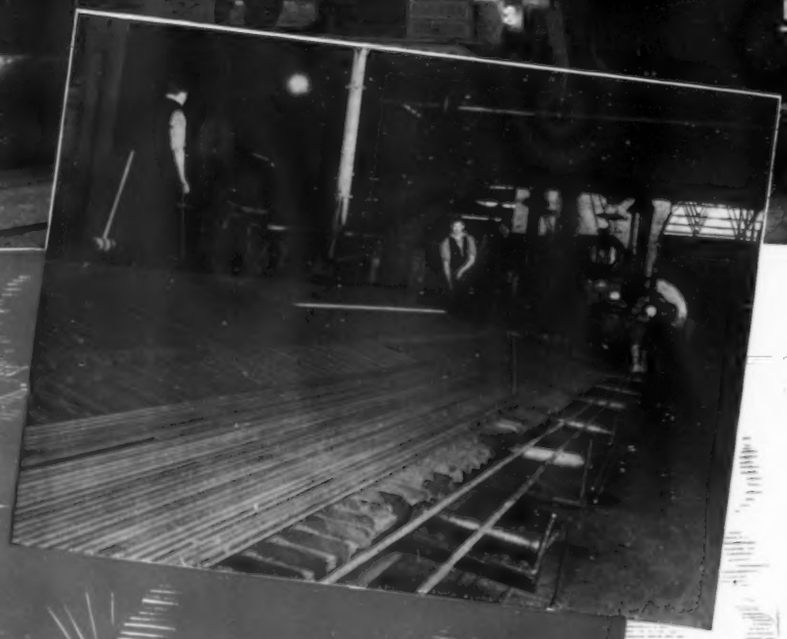

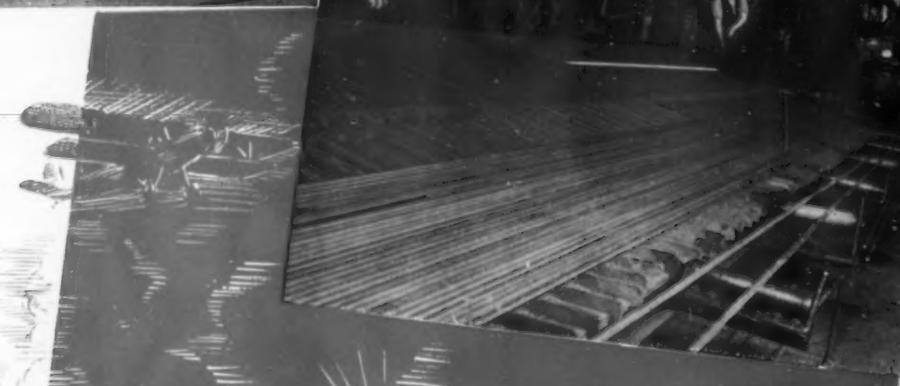

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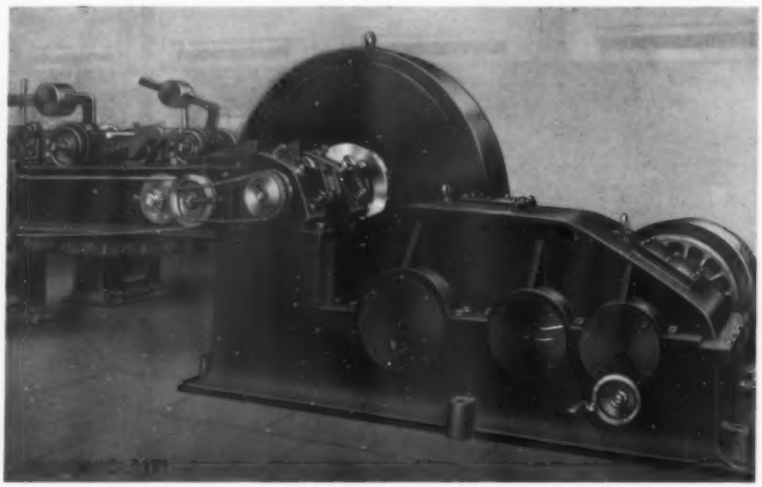

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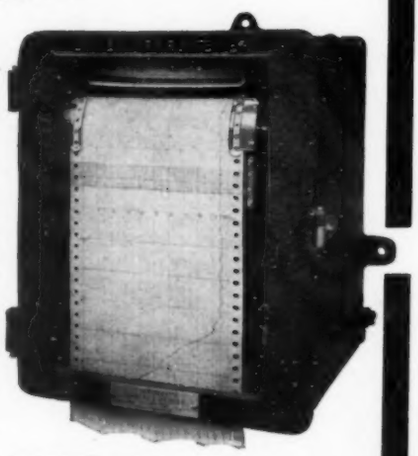

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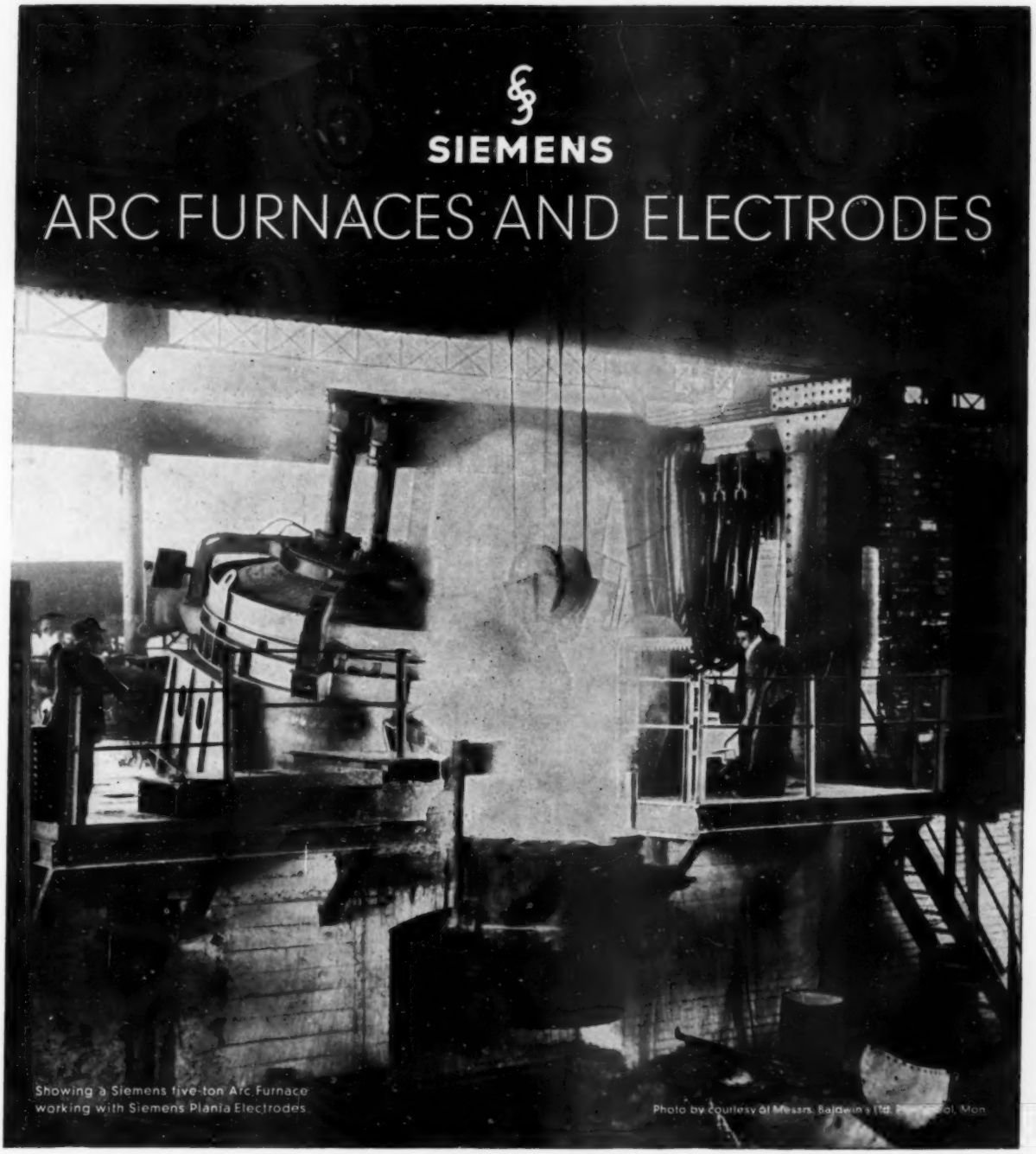
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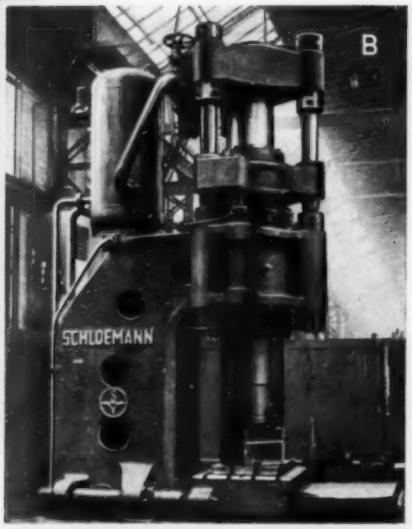

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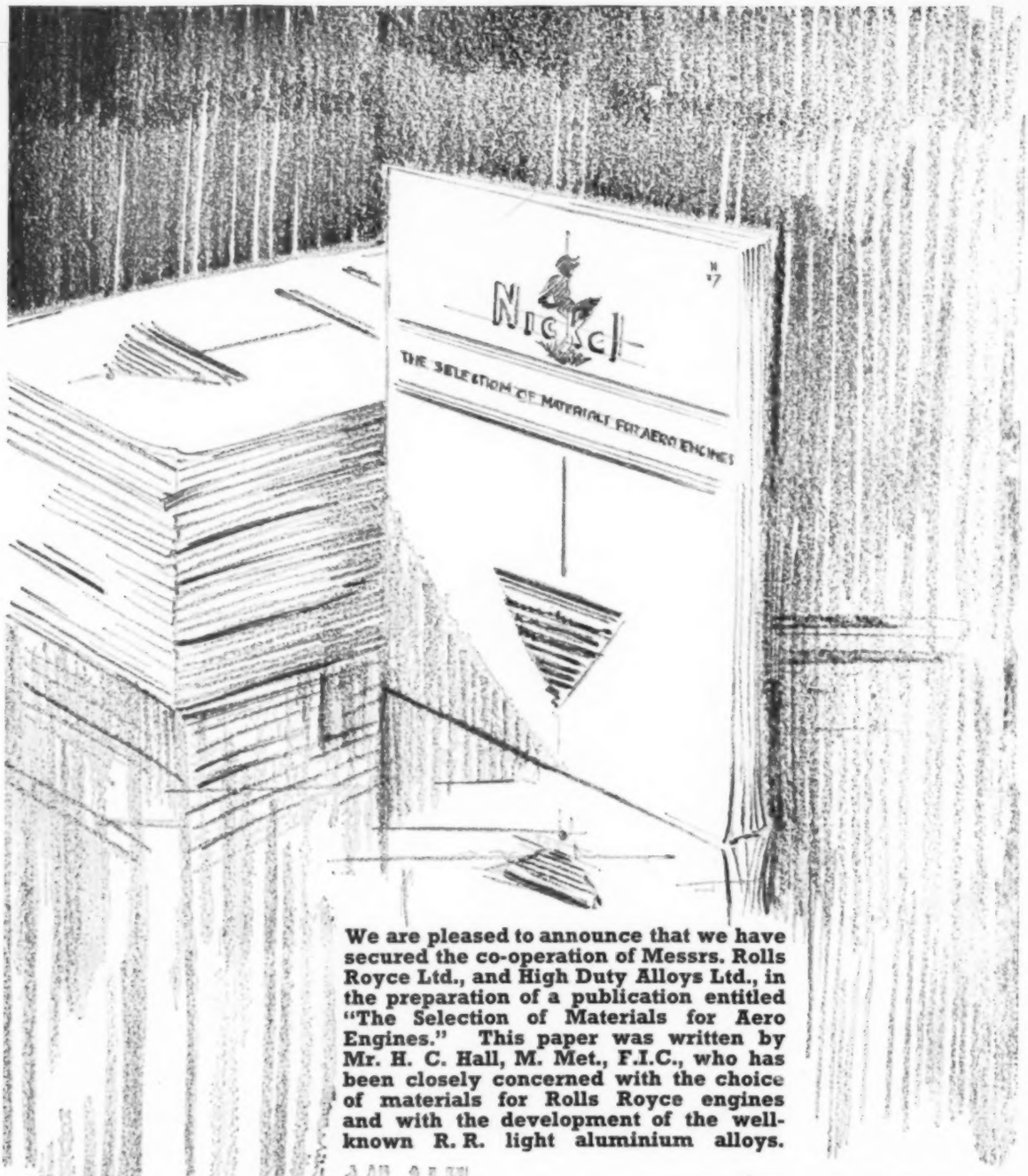

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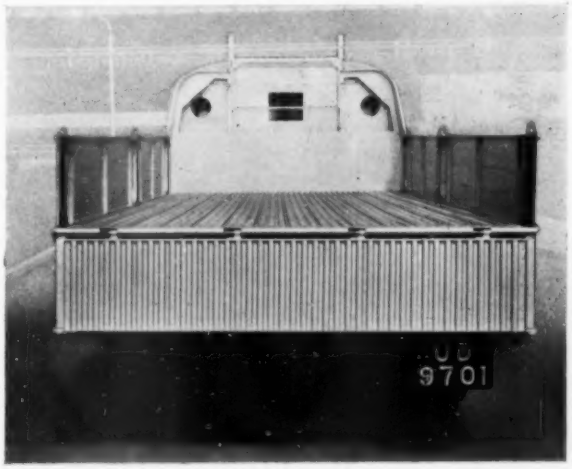
Motor-Lorry Bodies in Aluminium

The necessity for reducing weight to comply with restrictive regulations regarding the unladen weight of motor-vehicles has led to the judicious use of aluminium alloys, by which a substantial saving of dead-weight is achieved. A recent example is described, showing great progress in the use of extruded sections for this purpose.

IT is being increasingly recognised in all countries that the useful characteristics of the many aluminium alloys greatly increase their application, it is not surprising therefore that the high strength of these alloys per unit weight is responsible for the expansion in the use of aluminium in such important fields as the construction of motor-buses and trucks, aircraft, railroad rolling stock, etc. The great saving in "dead-weight" which can be effected, without sacrifice of strength, has caused the transport industries to make greater use of these light alloys. For railroad stock it seems that American and Continental railways employ aluminium to a greater extent than the railways of this country, but the general trend is favourable to its use. It is in the construction of road transport vehicles that great progress is being made in this country in the reduction of dead-weight. This is probably due to the many restrictive regulations introduced in recent years regarding the unladen weight of motor-vehicles. These restrictions, together with the methods of calculation for taxation, make the ratio of high-pay load to low unladen tare of major importance in the construction of motor-bodies, hence the use of aluminium has distinct economic advantages.

Apart from the saving in weight, which may mean a reduction up to about 50% as compared with the usual composite timber body, aluminium alloy bodies reduce maintenance costs by reason of their ability to withstand impact, and are not so readily disabled in service as vehicles of steel or wood. The cleanliness of aluminium bodies is another factor of importance, especially in connection with the transport of foodstuffs.

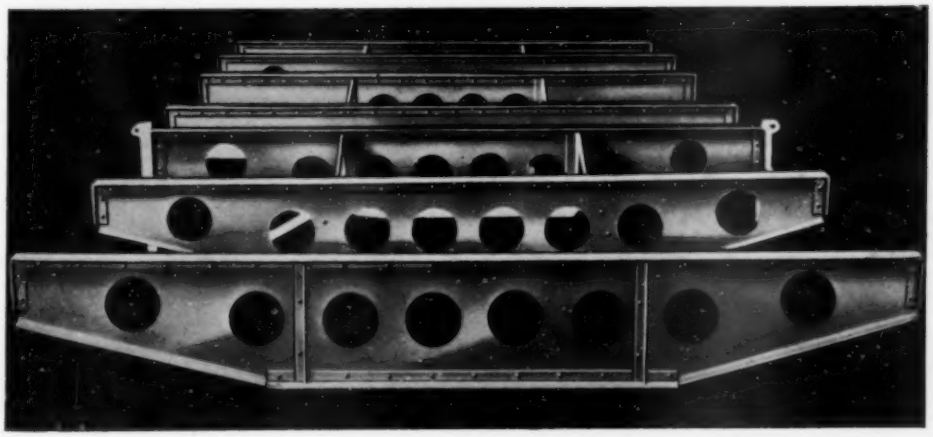
It is sometimes asserted that the cost of an aluminium alloy body, in comparison with a body for a similar load in a composite timber construction, is a deterrent to the more general use of the light metal body, but while this was probably true some years ago, to-day the manufacture of suitable standard extrusions has advanced to a high state, and this, together with improved design and facilities for assembly, has reduced the cost of an aluminium body, and, while the cost is more than the wood-composite body, the higher initial cost is readily offset by the increased pay load, economics in maintenance, and the high relative scrap value of the aluminium body when replacement is necessary.

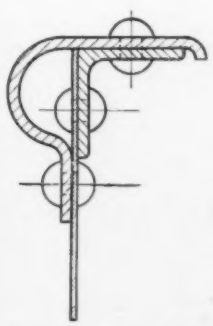


View from rear of lorry, showing the corrugated floor with gantry up.

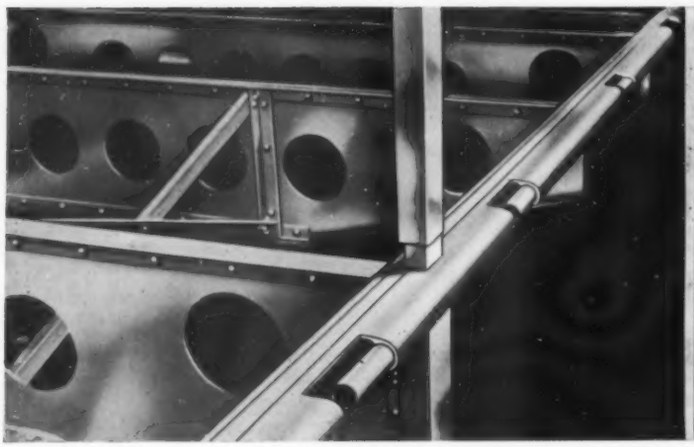
Some indication of the versatility of aluminium alloys for body building is shown by a lorry body designed by the Northern Aluminium Co., Ltd., for its transport fleet.

Deep crossbearers forming the underframe are shown with the loading board removed.

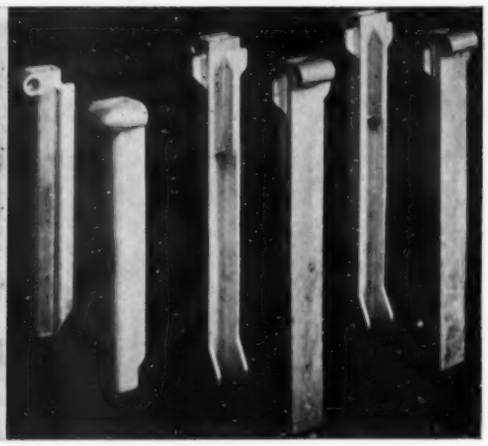




Section through side board top rail.



Side rave with centre post socket in position and post entered.



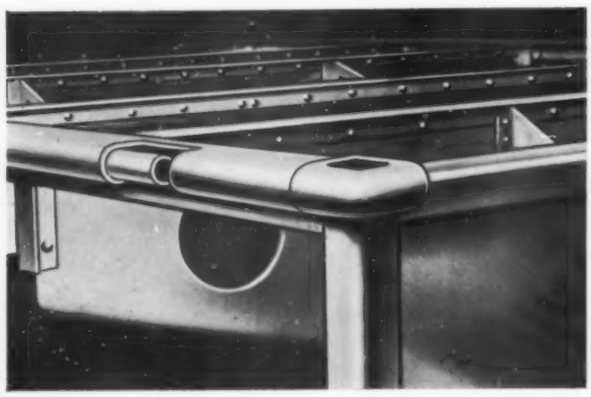
The socket posts shown are cast in a high strength aluminium alloy.

The unit has been designed to comply with current legislation in the 50-cwt. unladen class; but no sacrifice of strength has been permitted in achieving this object, and the principles of construction may be applied to any range by suitable modifications. Moreover, the saving due to the low-specific gravity of the structural material is utilised to produce a vehicle of pleasing appearance, easily serviced and maintained in a clean condition, rather than to obtain the minimum tare weight. Especially noteworthy in this design is the advantage taken of the constructional possibilities of extruded sections.

As will be seen in the rear view of this lorry, in the accompanying illustration, a corrugated aluminium alloy floor has been used. This consists of a series of sections, 14 S.W.G. thick, so designed that they overlap for jointing purposes, and have sufficient allowance in the overlaps to be accommodated in any overall width of floor, each section being $6\frac{1}{2}$ in. wide. The underframe consists of a series of deep crossbearers braced longitudinally to resist overturning moments due to braking and accelerating. Flat web sheets of medium-tempered aluminium-manganese-magnesium alloy are used, $\frac{1}{8}$ in. thick; these are shod at top and bottom with a slotted tee-extruded aluminium alloy section. Buckling over the chassis members is prevented by the vertical tee sections, to which are attached longitudinal bracings, whilst collapse of the upswept ends of the bearers outside the chassis is overcome by flanging the sheet. The longitudinal bracings are arranged between alternate bearers only, and are so placed that access is readily obtained to the transmission gear from outside the chassis.

Particular attention is directed to the construction of the side raves. These consist of a special extruded aluminium alloy section, which combines the functions of rave and hinge tube carrier, and by its broad dimensions permits cutting away for the fitting of post sockets without serious impairment of strength, which, incidentally, is largely restored by the tubes which pass through these sockets. The section, which has a recess on top to receive the floor, is attached to the cross-bearer ends by short lengths of slotted tee section and forms externally an effective "swipe rail."

Showing the construction of the side raves.



The post sockets are cast in an aluminium-copper alloy, which has a tensile strength of 18 tons/sq. in. and an elongation of 4% in 2 in. These castings incorporate the rectangular holes to receive the posts, the flanges for attachment to the cross bearers and side raves, and circular holes to receive the tube connecting the adjacent sections of the raves. In this instance the sockets are carried down at a reduced scantling to support the skirt boards, and are braced to the cross-bearers. In the case of the rear corner sockets, the circular contour of the side-rave section is carried round to avoid a sharp corner, and to withstand backing bumps a gusset plate is fitted between the flange cast on the socket and the side rave.

The end plate forming the gantry combines the functions of a loading board integral with the first cross-bearer web sheet and support for the gantry is provided for carrying long cases over the cab. There are two channel section central supports in which the gantry slides, being arranged so that it can be dropped below the cab-roof level when not in use. The side boards are of aluminium-manganese-magnesium alloy, 14 S.W.G. plate, stiffened vertically with extruded sections which carry the hinge plates, and with outer framing in one piece. The top rail consists of a combination of a special section and an angle, the former being designed to give great lateral stiffness and provide a neat finish. The tailboard is of special construction, to cater for loads imposed by long cases. The main sheeting is of corrugated extruded section, similar to that used for the floor; it is shod at top and bottom with suitable sections and covered on the exterior with thin alloy sheet.

With the exception of special sections for the front pillars and door frames, all members used in the construction of the cab are standard channels or angles, the grade of alloy chosen according to the amount and character of the forming required, and full advantage taken of alloy panelling.

The complete weight of this vehicle unladen is 2 tons 9 cwt. 3 qrs., the chassis however weighs 1 ton 18 cwt. 3 qrs., so that the weight of the complete aluminium alloy body and underframe, cab, rear wings and fittings, etc., is 9 cwt. 8 qrs., which is quite a commendable performance for a lorry of this type, and indicates what possibilities the use of light alloys offers in meeting current legislation while, at the same time, increasing profitable loads.

Cavitation Erosion of Metals and Alloys

Two investigations on cavitation erosion of metals and alloys are discussed and a comparison of the results is given from two methods of testing.

A VIBRATORY apparatus used for cavitation testing at the Massachusetts Institute of Technology was described in a recent issue of this journal,* and also the results of a series of experiments carried out by means of it. In those experiments the relative resistances of an 18/8 stainless steel, a cast iron, a brass, and a cold-rolled steel were determined, and also the effects of the fluid properties on the cavitation corrosion of an aluminium alloy of tap water, 20% sodium chloride solution, methyl alcohol, and carbon tetrachloride. This apparatus has also been used to determine the cavitation erosion of a large number of metals and alloys as part of an investigation undertaken in connection with the Passamaquoddy Tidal Power Development at Eastport, U.S.A., and the results obtained are discussed by S. L. Kerr.[1]

In the investigation 41 ferrous alloys, including cast and rolled plain and alloy steels and plain and alloy cast irons, and 37 cast and rolled and drawn non-ferrous alloys, including brasses, bronzes, high-tensile brasses, aluminium bronzes, silicon bronzes, and nickel-copper alloys were experimented with. Four to six test specimens from each alloy were each vibrated separately for 30 mins. and carefully dried and weighed to determine the quantity of material eroded by cavitation. This process was repeated twice, thus securing accurate values of weight loss at the end of 30, 60, and 90 mins. The tests were carried out both in fresh water and sea water at a constant temperature of 20° C.

In carrying out the tests, it was noted that a number of materials, particularly those having a high strength and dense grain structure, would not lose weight at a uniform rate throughout the entire 90-min. period, but would have a weight loss somewhat less than that experienced during each of the two subsequent 30-min. intervals. This was found with practically all high strength and forged materials, whereas, with low strength or cast materials, the loss was practically uniform from 0 to 90 mins., and during the first 30 mins. showed no signs of the lag that was present with other materials. Inspection of all individual test specimens also indicated that at the end of the first 30 mins. cavitation erosion was taking place at a relatively uniform rate, but during the first 30 mins. wide variations were present.

The nature of the cavitation indicated the desirability of distinguishing between those two actions and, as a result of the vibratory tests, two separate scales of relative resistance were set up. In the first scale the initial resistance to erosion is an index of the plastic deformation period prior to reaching the fatigue limit of the metal, and in the second the relative resistance to erosion is the index of the uniform erosion or pitting action, which takes place after the ultimate strength or fatigue limit has been reached. In Tables I. and II. are given, in summary, the relative order of resistance to cavitation erosion in both scales of the various ferrous and non-ferrous alloys.

A brief consideration of the results show that with both ferrous and non-ferrous alloys erosion is slightly greater in sea water than in fresh water. As regards ferrous alloys, chromium-nickel steels (18/8, 25/11, 8/21) are most resistant in both fluids and in both scales of resistance, and these are followed by 12% chromium steels and alloy steels, which include low nickel and low nickel chromium steel, and 36% nickel steel. Ordinary cast iron is least resistant, but alloy additions to cast iron increase the resistance slightly, particularly the relative resistance to erosion in fresh water. The resistance of cast and rolled carbon steels are of a similar character and are slightly better than alloy cast iron. With non-ferrous alloys, cast and forged aluminium bronze is most resistant, and is followed by cast and forged high-tensile brass, with cast, drawn, and rolled nickel-copper alloys (70/30 and 30/70) taking third place. Ordinary rolled brass and bronze and cast gunmetals are least resistant with cast, drawn, and rolled silicon bronzes occupying an intermediate position.

TABLE I.

INITIAL AND RELATIVE RESISTANCE TO CAVITATION EROSION. (FERROUS ALLOYS).

Relative Order.	Material.	Initial Resistance. Average Weight Loss for First 30-min. Exposure, Mg. per Hour.	Relative Resistance. Average Weight Loss for Last 60-min. Exposure, Mg. per Hour.
	Fresh Water.		
1	Steel (Cr-Ni)	3·6	15·6
2	Steel (Cr)	9·8	16·6
3	Alloy steel	18·6	43·7
4	Carbon steel	26·0	56·2
5	Cast steel	30·0	59·8
6	Alloy cast iron	57·6	61.0
7	Cast iron	74·2	70·4
	Sea Water.		
1	Steel (Cr-Ni)	3·6	15·5
2	Steel (Cr)	9·4	18·1
3	Alloy steel	22·4	48·9
4	Cast steel	37·2	65·6
5	Carbon steel	38·6	67·9
6	Alloy cast iron	81·8	74·3
7	Cast iron	91·0	87·0

TABLE II.

INITIAL AND RELATIVE RESISTANCE TO CAVITATION EROSION (NON-FERROUS ALLOYS).

Relative Order.	Material.	Initial Resistance. Average Weight Loss for First 30-min. Exposure, Mg. per Hour.	Relative Resistance. Average Weight Loss for First 30-min. Exposure, Mg. per Hour.
	Fresh Water.		
1	Aluminium bronze	9·6	26·8
2	High tensile brass	19·2	36·0
3	Silicon bronze	41·8	52·5
4	Nickel copper alloys	44·6	60·3
5	Cast gunmetal	69·6	72·6
6	Cast bronze	71·2	73·3
7	Rolled brass and bronze	87·6	90·1
	Sea Water.		
1	Aluminium bronze	7·2	26·2
2	High tensile brass	20·2	35·6
3	Silicon bronze	39·0	52·3
4	Nickel copper alloys	42·0	58·8
5	Cast gunmetal	63·0	69·2
6	Cast bronze	70·6	70·9
7	Rolled brass and bronze	86·0	83·5

An extended investigation on cavitation erosion of metals and alloys has also been carried out in the United States by J. M. Mousson,[2] for the Safe Harbour Water Power Corporation. The apparatus used for these tests was of the Venturi

* METALLURGIA, 1937, Vol. 16, Pp. 135-136.

1 Trans. of Amer. Soc. of Mechan. Eng. 1937. Vol. 59. No. 5. Pp. 373-397.

2 Trans. of Amer. Soc. of Mechan. Eng. 1937. Vol. 59. No. 5. Pp. 399-408.

type, a zone of cavitation being produced by means of a double weir arrangement. Two test specimens of each alloy were inserted in the parallel side walls of the apparatus, opposite to each other, instead of one specimen being placed opposite the guiding weir. A head pressure of water of 480 lb. per sq. in., with a back pressure of 25 lb. per sq. in., was maintained during a run of 16 hours' duration, at a temperature of 20° C. The amount of cavitation or pitting was determined from the weight lost during the test, and for comparative purposes the loss in volume was used to compensate for differences in the specific gravity of the various materials.

The tests were carried out on over 200 metals and alloys, including plain and alloyed cast irons; cast, rolled, and forged plain and low alloy steels; cast and rolled stainless and high alloy steels; forged and cold-drawn alloy steels; cast non-ferrous alloys; rolled and extruded non-ferrous alloys; surface-treated materials, including chapmanised, nitrided, and clad steels, and cloud-burst hardened 18/8 steels; electric arc-welded low alloy steels, stainless chromium steels, and 18/8 chromium steels; acetylene-welded non-ferrous metals, and sprayed materials.

From the losses obtained for the various alloys and from microscopic examination, it was indicated that erosion occurs either from failure due to successive deformations in the zone of highest stress concentration after the capacity of yield has been exhausted or failure was due to fatigue beneath the zone of possible yield, where some stress distribution has already taken place. The relationship of yield-point, capacity of deformation, and fatigue limit differ in various alloys, and, depending on these as well as upon the severity of cavitation, one or another type of failure may predominate.

Cavitation loss in the ferrous alloys was highest in the ordinary cast irons, and is reduced considerably by the addition of special elements, provided the structure is changed from ferrite to austenite and the graphite size remains unchanged. In the non-ferrous alloys the highest cavitation losses were obtained in aluminium alloys, both cast, extruded, and rolled. The losses obtained in carbon and alloy steels were considerably less than those obtained in cast iron, and the same might be said of most non-ferrous alloys. Relative losses, however, were influenced by composition and properties. Steels which were susceptible to work-hardening were in general more resistant than other steels, and the same applies to other alloys. An 18/8 chromium-nickel steel, with a lower hardness and yield-point than a 17% chromium steel, showed a superior resistance to erosion, and a similar tendency was found in the 24/12 and 26/13 steels. In some cases, however, work-hardening did not overshadow the original hardness.

In addition to the influence of work-hardening, grain size was found to be of far-reaching importance, not only the original grain size, but also grain size produced by casting conditions, heat-treatment, and the addition of special elements. This was shown by results obtained from both ferrous and non-ferrous alloys. The results obtained also indicate that rolling and forging are advantageous and often superior to casting in the fact that better physical properties are obtained. Rolling and forging may be detrimental, however, in cases where a well-defined stratification is produced which is conducive to separation along parallel grain layers, and a weakness from this source becomes particularly apparent, where, due to processing and heat-treatment, a laminated structure is obtained consisting of large grains.

In surface-treated alloys large cavitation losses were obtained with Chapmanised and nitrided steels, due to the shallowness and brittleness of the skin, and the same occurred in an aluminium alloy with an aluminite finish. The results obtained with cloudburst hardened steels are of interest, due to the fact that cold work increases the fatigue limit in the work-hardened zone, the losses of both 0·33% carbon and 18/8 steel being reduced considerably. A definite maximum in surface hardening, however, can be reached, and if the treatment is carried too far the surface hardness decreases with a corresponding increase in the pitting erosion. With regard to the results obtained for welded materials, the stainless chromium steels show the best average resistance, while comparison of the cavitation losses obtained on welded and sprayed deposits of materials similar in chemical composition showed that welding produces structures which are more resistant, so that spraying can only be recommended for very mild cavitation conditions.

In his investigations, Mousson also subjected a representative number of specimens identical with some of those exposed to the cavitation test to a water-jet test. When the results obtained by the two types of tests are compared it is concluded that cavitation and water impact are fundamentally different. The losses obtained by water-jet tests, however, can be grouped similar to those of the cavitation experiments, and from this fact as well as from micro-examination the conclusion is drawn that the various factors governing the rate of pitting are nearly identical for both types of failure, and that for all practical purposes the data obtained for the cavitation tests can be used as a guide for selectng materials exposed to impact due to water jet or drops of water, such as are present in impulse turbines and in the low-pressure stages of steam turbines.

A comparison of the cavitation erosion obtained by the Venturi and vibratory methods of testing were made by Kerr,[1] when it was shown that the results by the two methods cannot be compared directly. Other factors have to be considered, and as a result of a detailed study of the data obtained by the two methods for bronze, cast-steel, and cast iron, a comparison of relative resistance was made and is given in Table III.

TABLE III.

COMPARISON OF RELATIVE RESISTANCE BY VIBRATORY AND VENTURI METHODS.

Material.	Vibratory.		Venturi.	
	Fresh Water.	Sea Water.	Fresh Water.	Sea Water.
Bronze	1·6	1·5	60·0	55·0
Cast steel	1·2	0·95	1·6	5·6
Cast iron	1·0	0·54	1·0	0·2

From consideration of these results it is evident that the same relative behaviour is found in the two methods. The appearance of the individual specimens indicated that the action in the Venturi apparatus proceeded at a much slower rate than is the case in vibratory testing. In the Venturi tests, the bronze and the stainless steels gave the appearance of severe hammering having taken place on the surface and, as the test continued, these surfaces gradually assumed a pitted appearance, whereas in the case of cast iron, which is brittle, the initial stage is practically non-existent, and pitting action begins at once.

The merits of Luke and Spencer abrasive wheels and grinding machines, which run at speeds up to 80% higher than is regarded as normal practice, are well presented in that company's 1938 desk calendar. The calendar, to quote the introduction, "endeavours to portray the spirit of the age, 'Speed' . . . this increase (80%) is in harmony with other services on land, sea and air."

This is a very handy spiral bound calendar that is useful for reference and presents the company's grinding wheels, centreless grinders, high-speed machines, sticks, segments, saw sharpeners and other specific applications of abrasives. Their address is Kinnell Works, Broadheath, near Manchester.

Vickers Limited announce that General Sir J. F. Noel Birch, G.B.E., K.C.B., K.C.M.G., has intimated his desire to retire from the board of the company, and that h is wish has been acceded to with regret.

METALLURGIA
THE BRITISH JOURNAL OF METALS.
INCORPORATING "THE METALLURGICAL ENGINEER"

Factors Affecting British Trade

THE progressive deterioration of Britain's balance to payments and the growing difficulties experienced by her exporting industries are causing considerable alarm in many quarters, and while various factors influencing the desired maintenance of trade should be the serious concern of the whole nation, there are no sane grounds for the extreme pessimism with which some people seem to regard the lull in the progress of trade and industry experienced during the last few months. Trade between Britain and the various countries is very complicated and is built on delicate lines, so that its operations are quickly disturbed by international influences which endanger peace, causing uneasiness and a tightening of trade conditions. The tendency in many foreign countries is to place too much political significance on trade, and this, together with many restrictions, is hampering the free interchange of goods and materials. Because of her widespread trading ramifications and her desire to maintain freedom of trade, which is one of her trading characteristics, Britain's international trade is more readily affected by these disturbing influences than is that of any other country. So delicate is Britain's trading structure, which has been built up patiently through many generations of merchants, that efforts to weaken the structure, by means of disturbing gestures endangering peace, are probably engineered as a competitive weapon, and for this reason stronger measures should be adopted to preserve fair play in the world's markets for Britain's manufacturers.

Britain's overseas trade during the last six months shows signs of contraction, both imports and exports are affected, and the difference between the imports and exports is very greatly in favour of imports, much more than are likely to be covered by what are known as invisible exports. It is true, of course, that the adverse balance is partially the result of the rearmament programme, resulting not only from the increase of raw material imports, but from the inability of works to cope with orders for export in view of rearmament demands. But this does not entirely account for the lapse in export trading returns. In a considerable measure Britain's trade is affected, to her disadvantage, by her desire that all countries, from which she purchases goods or materials, should be free to obtain their own requirements wherever they choose, however much the adverse balance may be against Britain in the trade conducted. Trading figures seem to indicate that the many agreements which have been arranged between Britain and foreign countries have proved excellent for the foreign countries concerned, but it appears to be very doubtful whether the benefits to this country have been such as to warrant special trading concessions.

Britain has done much to earn the good will of all nations, by which they have not been slow to profit; it has, in fact, almost become a habit of this country to make sacrifices with a view to stimulating progress, but very few countries seem to show any readiness to reciprocate on anything like the same generous scale. International trade is vital to this country, and much stronger measures must be taken to preserve an amicable balance between imports and exports; agreements and trade treaties with other countries must give assurance of equal terms and fair play for British manufactured goods; no longer can this country afford to make unilateral gestures in trade matters merely to foster good will. It is not suggested that assurances should be obtained by questionable methods, but simply by making fuller use of Britain as a market for foreign countries, the balance between the imports and exports from and to any country with which Britain does business must be on a fairer basis than at present exists. As far as Britain's export trade is concerned the gradual pilfering of her many markets seems to be viewed with too much complacency, yet the very countries that are using every possible measure to undermine her influence in these markets, are finding it relatively easy to increase their exports to Britain.

By many subterfuges of her competitors, which by no stretch of imagination can be regarded as fair trading, Britain, by her passivity, is allowing valuable business to go elsewhere. The decline in mercantile shipbuilding activity may be mentioned only as one instance. The tonnage of merchant vessels under construction at the end of the June quarter was just over 1,000,000 tons, a reduction of nearly 200,000 tons in comparison with the June quarter last year. But the fact that launchings were nearly double, the tonnage of work under construction makes the position more serious. Launching and new construction figures abroad are almost identical. Some 17% of the tonnage being built is for overseas buyers compared with 30% of the construction total destined for export by foreign builders. Some of the work now in foreign yards is for account of British owners; work valued at about £5,000,000 has been mentioned in this connection.

The shipbuilding industry, like the other principal industries, finds itself burdened with heavy charges for social expenditure, high wage rates and the high cost of important raw materials, in comparison with many of its foreign competitors. But it is not so much the high relative costs in this country that need attention as the extent of subsidies supplied by foreign governments which make it possible for their industries to export at prices below cost. To attempt to compete under such conditions by a substantial reduction of wages and of steel prices is not likely to meet with success, and the extension of the export credit facilities do not seem to have made any appreciable difference in assisting the building of vessels for foreign owners, it seems, therefore, that this is another industry which could be improved by strong Government action. The adoption of a definite policy in shipping and shipbuilding—both of vital importance in national defence—would quickly revive two industries which have a big influence on trade.

Production in the iron and steel industry is not on the scale experienced towards the end of last year, but steel, in particular, is being produced on a reasonably high level and, with the gradual reduction of accumulated stocks, pig-iron conditions are likely to improve with the autumn. Without being unduly optimistic, it can be said that the consumption of steel in this country indicates a satisfactory position of the industry, and one which should ensure reasonable profit from the year's working.

The most important factor operating against trade is the condition of unrest in the world which has existed so long. Every nation is preparing for war while proclaiming that its intentions are entirely peaceful. This condition

is fatal to prosperity. It is recognised that defensive measures are imperative in this country, but the burden of armaments is reaching a point which threatens ruin or grave embarrassment to all countries. If the European nations were as civilised as they pretend this condition of unrest would be dissipated, and with it the danger to world prosperity. On the whole, there are indications that the international situation is improving; the tension is certainly less in Europe and there is more reason to think that the nations of the world will settle down to peaceful, cultural and commercial relations, from which not only would British trade improve, but that of the whole world.

Canadian Radium and Uranium

CANADIAN production of radium and uranium ore in 1937 continued to be confined to Eldorado Gold Mines, Ltd., now in its seventh year of operating the important pitchblende deposits discovered in 1931 at La Bine Point, Great Bear Lake, in the North-West Territories. Since this original discovery a few other occurrences of the mineral have been reported at scattered localities in the same general region.

The Eldorado mine was in steady operation and production throughout the year. Underground development was continued on the main, or No. 2 vein, by further drifting to the west on the three lowest levels, at 250 ft., 375 ft., and 500 ft., respectively, below the adit. In addition, exploration of the hitherto undeveloped No. 1 parallel vein was started from a cross-cut driven south from the shaft on the 500-ft. level, followed by a second cross-cut on the 250-ft. level. Both these were driven to prove the assumed downward continuation of the rich ore-shoot in the original surface discovery pit on this vein, and on each level important lengths of pitchblende were found. A cross-cut was driven on the 250-ft. level to explore the No. 3 parallel vein exposed on surface to the north, the downward persistence of which to this depth is reported to have been determined. In addition to the above work on La Bine Point proper, a second shaft was sunk during the year in the gulch at the head of La Bine Bay, at a point 4,000 ft. north-east of the main workings, and on the strike of the No. 1 vein; this shaft was carried to 125 ft. Cross-cutting and drifting is reported to have yielded encouraging results. Conditions on the lowest level, at 590 ft. below surface, show persistence of strong and well-mineralised breaks to this depth.

A large new bunk-house and cook-house, assay office, addition to store-house, electric transmission line to the gulch shaft, and additional tank storage for fuel oil were built. An 8-mile pipe-line around the rapids on Great Bear River has been laid, thus avoiding the costly transport of oil in drums and small river boats from the wells at Norman on the Mackenzie river to the Eldorado mine. New Diesel-powered boats went into service on the waterways—Fitzgerald and Fort Smith-Fort Norman stretches of the Athabaska, Slave, and Mackenzie rivers, and a large tank-barge was built and placed on Great Bear Lake to transport oil from storage established at the head of Great Bear River to the mine. Eldorado Company has acquired the transport business of Northern Transportation Company. As a result of this, as well as by the completion of the truck road around the Great Bear River rapids by the Dominion Government in 1937, transport has been speeded up with a corresponding decrease in freight costs.

The total installed power was raised to 834 h.p., all furnished by Diesel equipment. Present mill capacity is around 75 to 80 tons per day. Additional screening, jig, filtering and drying units were installed toward the end of the year. Mine working force totals 110 men. The company reported 1,062 tons of machinery and equipment supplies landed at the property during the open navigation season, and 561 tons of ore shipped out. The latter included 391 tons of pitchblende-silver jig table concentrate and cobbed high-grade pitchblende and silver, and 170 tons of silver-copper flotation concentrate. The two former products are consigned to the radium refinery at Port Hope, Ontario, and the last to smelter at Tacoma, Washington.

The Consolidated Mining and Smelting Company has done considerable work on a group of claims at Common Lake, adjoining the Eldorado property to the north-east, and drifting from two adit cross-cuts has disclosed both silver and pitchblende. Work was suspended in June, 1936, and has not since been resumed. A few tons of crude pitchblende and silver ore is stated to have been sent to Trail. Small amounts of pitchblende have also been found in certain portions of the workings of the mine being operated by B.E.A.R. (Bear Exploration and Radium, Ltd.) at Contact Lake, 10 miles south of La Bine Point, but so far this property has been found to carry mainly silver-cobalt and nickel. No recent development has been reported on the pitchblende discoveries made several years ago at Beaverlodge and Hardisty Lakes, about 100 miles south of Great Bear Lake. From the Arden group of claims at Beaverlodge Lake several tons of crude pitchblende ore were mined and shipped in 1934. This ore consisted of an intimate mixture of pitchblende and hematite, occurring in pockets or lenses in a large quartz body; it is thus distinctly different to that at Great Bear Lake, where the pitchblende occurs in definite veins, associated with native silver and cobalt-nickel arsenides. A discovery of pitchblende was also made in 1935 near Goldfields, on Lake Athabaska.

Development of Commercial Recovery Methods

It is noteworthy that during a discussion before the Society of Chemical Industry at Ottawa recently, Mr. F. B. Friend, physicist at the Port Hope, Ontario, refinery of Eldorado Gold Mines, Ltd., stated that Madame Curie Joliot, daughter of the famed discoverer of radium, is at work on ores from Canada's sub-Arctic radium deposits. Her objective is the development of commercial methods for the recovery of other minerals of the radium group, particularly radium D, which have not yet been produced industrially.

Radium D is now found in the lead which is separated from the ores during the processes of extracting radium for medical use. Polonium, another radio-active element, also discovered by the Curies, is likewise present in Canadian pitchblende, but has yet to be produced on a commercial scale. Its possibilities are being studied. Ore and residues from the Port Hope radium refinery have been shipped to the Curie laboratories in France, so that the research could be carried on.

Plating Shop Extensions

THE plating shop of the machinery department of Edgar Allen and Co., Ltd., has recently been extended by some 150 ft., the span being 50 ft. This shop is employed as a heavy erecting shop for the platers in the manufacture of crushing and grinding machinery, cement plant, rotary dryers, etc. An additional three-roll plate bender which will be used on the larger circular work, such as tube mills and kilns, has also been installed. The machine is capable of bending mild steel plates up to 1¼ in. thick of a maximum width of 20 ft.

Electrical Equipment for Rolling Mills

EVIDENCE of wide experience in the electrification of rolling-mill plant for the iron and steel and non-ferrous industries is given in a new Bulletin No. 29, which is issued by The General Eelectric Co., Ltd., Magnet House, Kingsway, London, W.C. 2, and shows a large number of representative installations selected from the many schemes completed by the G.E.C. in this country and overseas. From the illustrations reproduced in this publication, it appears that the schemes undertaken by the G.E.C. have involved the design, construction and installation of rolling-mill motors up to 20,000 h.p., steelworks motors for driving-mill auxiliaries, transformers and switchgear of the most modern design for the control of the plant.

The Preparation of Aluminium Alloys for Microscopical Examination

By George Mann

Methods are discussed for overcoming difficulties encountered in the preparation of aluminium alloys and other soft-metal specimens for microscopical examination. Recommended etching agents are also given.

ALUMINIUM and many of its alloys can be considered as relatively soft. This property of softness renders the preparation of specimens for microscopical examination—and subsequently for photography—a difficult one, in so far as the analysis of an aluminium alloy by microscopical methods is more difficult than that of iron and steel.

It is necessary, therefore, that in order to recognise the various characteristic structures associated with aluminium alloys, the method of preparation of the surface for examination should eliminate any possible result that would tend towards ambiguity.

The following method is suggested as a means of overcoming the major difficulties attendant upon the preparation of such alloys for microscopical investigation, and further information is given relating to examination and photography.

Initial Preparation of the Specimen

In selecting the size of specimen due regard must be paid to the cutting or sectioning. Under no circumstances is it advisable to cut a specimen by means of any saw operated mechanically. The usual hack-saw possessing rather coarse teeth is recommended. The cutting should be done at such a rate that the friction produced does not overheat the surface to be examined. Further, the method of holding the section being cut should not result in excess pressure being applied sufficient to cause distortion of the crystal structure. The filing of the surface to be examined should be done with deep-grooved files. This operation of filing, if done well, reduces the polishing work considerably.

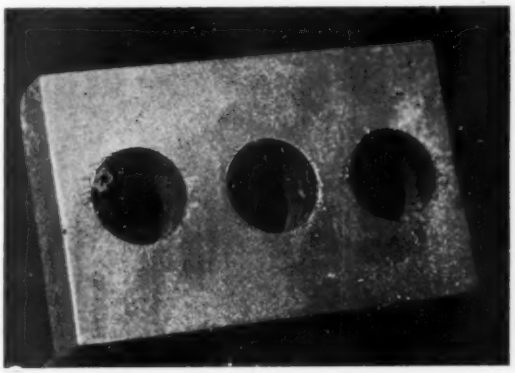
One of the major difficulties associated with the preparation of specimens for microscopic examination is that of having a suitable material into which the specimen may be embedded, and thus enable it to have a uniform surface preparation.

This is never more important than when the edges of the specimen have to be examined for possible faults—e.g., the corrosive effect on a particular surface. Various media have been suggested for aluminium and its alloys, but the following may be taken as satisfactory for most purposes: Wood's or type metal and hard sealing-wax. These are melted in a suitable receptacle, overheating being avoided. They are then poured into moulds such as a metal block, as is illustrated in Fig. 1, or little moulds prepared from aluminium tubing, the height of which need not exceed 2 cms. The diameter will vary according to the size of the specimen.

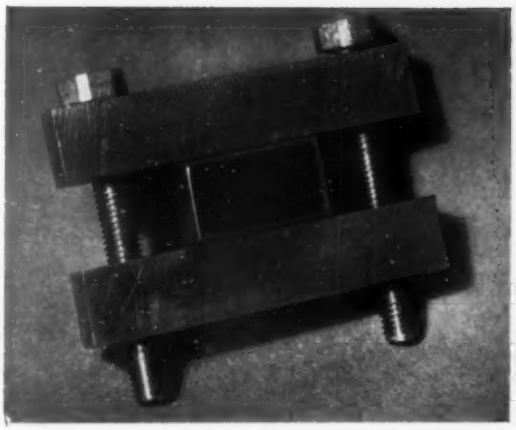
Various non-metallic mounting substances are finding increasing favour, and are to be preferred if electrolytic influences are to be excluded during etching; such substances are bakelite and ebonite. Thin sheet, is preferably prepared by being held in a small vice between two thick pieces of sheet of the same material.

Grinding

The grinding operations are best done by hand. In many cases, particularly where routine work of a large nature is undertaken, machine polishing becomes imperative; but then the examination is usually superficial. For work where the analysis is of a more searching kind, grinding by hand is preferable. The mechanically-driven grinding disc results in an increase of surface temperature and subsequent variations of structure.



An aluminium mould for mounting specimens in type metal or sealing wax.



A steel clamp for varying sections showing a specimen polished and ready for examination. ×2.

The usual grades of emery paper that are used are 1G; 1M; 1F; and Hubert's O; OO; 30; 40; and 50. Sheets usually of 34 cm. by 23 cm. in size are placed on a heavy steel block, liberally covered with paraffin oil. The grinding marks are removed by rubbing the specimen on each succeeding paper, so that the direction of rubbing is at right angles to the marks made by the preceding paper. After each grinding operation the specimen is thoroughly cleaned by washing in a stream of soapy water, before proceeding to the next operation. After the final paper the specimen is washed in a stream of soapy water, and finally in acetone; the latter to make sure no particles of grease remain.

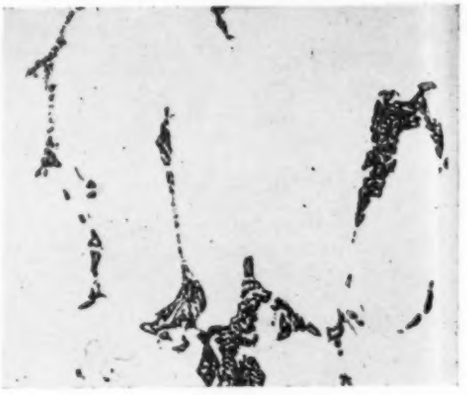
Polishing

The final polishing is of paramount importance, and whereas five minutes suffice for the grinding operations, 20 at least are required to ensure a satisfactory final surface suitable for examination. Quick-rotating discs arranged horizontally are to be preferred, as they enable the operator to apply that lightness of touch which is so essential, without overheating the surface.

Two rotating discs with speeds of 1,000 to 1,500 r.p.m. are used; one for preliminary work, the other for applying

An aluminium alloy showing excessive relief polish. ×100.

A section of Duralumin showing decreasing relief polish. ×100.



A specimen of Duralumin suitably prepared. ×100.

the final polish. The discs are covered with thick cloth of the "Selvyt" variety, stretched very tightly. It is necessary that the cloth be pulled as tightly as possible, as the smallest degree of sagging causes pitting and dragging of the specimen.

On the first disc is placed the proprietary polishing media, "Silvo." This should be constantly moistened by a liberal use of white spirit. On the second disc is placed a further polishing media known as "Nekotol." This also should be liberally moistened with white spirit, and results in a very high polish being imparted to the specimen: a useful point where the subject has to be photographed.

In some cases magnesia can be used mixed with water in the ratio of one part of powder to six of water. It is not recommended where the alloys are particularly soft—e.g., alloys of aluminium and magnesium, as it often causes deep scratches and misleading analysis.

The polishing should be commenced on the outer part of the disc, passing gradually to the centre. Sometimes a very high finish can be obtained by a final polish on a third disc using alcohol as the polishing media.

In all these operations the degree of pressure to be applied should be a decreasing one, finishing with a very light touch; and to remove the effects of cold work on the surface metal the specimen is given a light etch between each successive polish with a solution of 1% HF. in water.

Etching

Many of the structural constituents are to be seen without etching, although various etching reagents serve as confirmatory tests to previous findings. The class of constituents observable in the specimen when in the unetched condition are shown in the table below; porosity, oxides and folds, etc. are easily recognisable.

The following etching reagents are recommended for general work:

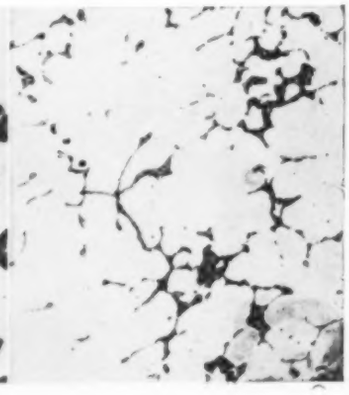
i. Hydrofluoric acid ..	1·0 c.c.	For grain contrast etching. Etching time 10-20 secs., followed by washing in cold water, and drying in a hot-air blast.
Hydrochloric acid ..	1·5 c.c.	
Nitric acid	2·5 c.c.	
Water	95·0 c.c.	
ii. Nitric acid	1 vol.	Suitable for bringing out the general structure, but also serves as means of identifying structural constituents which commonly occur.
Hydrofluoric acid ..	1 vol.	
Glycerine	3 vols.	
iii. Caustic soda solutions of 5–20% in water		For grain boundary development. Etching time 30 secs., followed by a quick dipping in concentrated nitric acid, and washing in a stream of cold water.
iv. 10% *Sulphuric Acid.*		

The solution is used at a temperature of 70° C. It is particularly suitable for rendering a black colour the iron aluminide prominent in alloys of high iron content.

TABLE I.
(A.S.T.M.) HANDBOOK.

Structural Constituents.	Colour by Arc or Pointolite.	Characteristic Form
Complex Fe-Al-Silicide..	Lavender	Crystal skeleton, *i*
$CuAl_2$	White and pink ..	Needles and Granules, *ii*
$FeAl_3$	Lavender to purple	Needles, *iii*
Al_3Mg_3	Light Whitish	Needles and granules, *iv*
$Mn.Al_3$	Blue Grey	Similar to *i*; Needles and crystal, *vi*; skeletons
$Ni.Al_3$	White	Needles and granules, *vii*
Si	Blue Grey	Granules, needles, and dendrites, *viii*
Mg_2Si	Blue	Granules, *ix*
Ternary entectic between $CuAl_2$; Mg_2Si and Al rich solid solution	Interwoven light and dark parts...	Lace pattern, *x*

An aluminium alloy showing signs of "drag" polishing. ×100.



A specimen of Duralumin suitably prepared. ×100.

Drying of Etched Specimens

After etching the specimens are well rinsed in running water, and then dried. It is particularly important that the formation of spots by slow evaporation should be avoided.

It frequently happens, during drying and even during observation under the microscope, that a fluid appears from holes or cracks, spoiling the polished surface. This danger is particularly great where the specimen is allowed to dry by itself. It can be obviated if the specimen is dried quickly. This can be done either by placing the specimen face downwards on blotting paper, previously dried in a hot-air oven, or by first immersing the specimen in acetone distilled over calcium chloride, and then placing it on blotting paper as before. A hot-air blast is also suitable.

Specimens to be photographed should be done immediately after etching, as the etch attack renders the surface susceptible to staining when left exposed to the atmosphere.

Diesel Engine Metals

By Robert W. Maughan, M.I.M.E., M.I.C.E. and M.I.S.E.

Metals employed in the production of Diesel engines are briefly discussed. Cast iron predominates and attention is directed to the use of nickel for improving the quality of castings. Reference is made to bearing metals and some compositions are given.

MODERN engine design, in which the speeds, pressures, and temperatures involved have all increased, has brought into greater prominence the characteristics and selectivity of metals. Obviously, engine design would be simplified considerably if all metals expanded to the same degree, or preferably, not all at. These and other variables, however, necessitate with increasing care, selection of metals and alloys for the innumerable details of engine design. For road and rail vehicle uses high speeds with low weight are necessary; for stationary engines weight becomes of less importance, but strength and reliability are required in both cases. Cast iron, of which there are many varieties, figures largely in the construction of Diesel engines, and, in general, the mechanical properties of this material depend largely upon the structure of the grains; a medium, even, fibrous grain denotes good iron. The more important elements are carbon, either graphite or combined, silicon, manganese, phosphorus, and sulphur, the relative percentages of of which influence the soundness and strength of the metal. Composition, however, is not the only consideration in the production of castings of uniform quality, the designer being interested in both initial composition and the finished casting, which requires an intimate knowledge of foundry practice and some acquaintance with metallurgy.

In machine design, particularly with high-speed engines working on high-impulse pressures, vibration is a factor of considerable importance, and regard must be taken of possible sychronisation of the several vibrational impulses which, if not checked, may result in breakages. Worn or pitted piston rings result in a loss of power, increased fuel and oil consumption, while, in addition, breakage may cause considerable damage to the piston and cylinder walls. Cylinder wear is best met by renewable liners of special cast iron suitably treated. Piston rings should, therefore, be of sufficient strength to withstand normal working stresses, have a high elasticity with freedom from permanent distortion, and give good resistance to wear.

As a quality-improving agent, nickel, in varying proportions, has been added to iron castings for engine parts for several years. Under suitable conditions, additions of 0·5 to about 2% nickel improves the quality of the castings by a refinement of the grain, and increased hardness for wearing parts is readily obtainable by a nickel addition up to 5%. The use of nickel cast iron for appropriate parts ensures long life with a minimum of wear and overcomes production difficulties with respect to porosity in castings and machinability, the latter being important from the point of view of production costs. With some types of strong iron, in which there is a tendency to hard spots and chilled edges, a simultaneous increase of strength hardness and machinability may be obtained by the use of nickel in so far as it promotes graphitisation. On the Tangye high-speed transport engine a high-nickel and high-silicon cast iron was used for the hot body, and a cast iron with a lower nickel content used for the cylinder heads. Machinability depends upon the speed at which metal may be cut and removed, and surface finishings applied, to the metal; carbon and phosphorous percentages are the most significant factors affecting it. An increase of the graphite content will probably improve the machinability, but more graphite means lower strength of the iron, and the designer has to adjust the varying percentages according to the different pressures, etc., expected of the particular engine part. Any comparision, or selection, of metals for use in oil engines should, as far as possible, be made after actual service conditions from which the designer may collect important data as to several values of pressure intensity, degree of contact, velocities, temperatures and behaviour.

Bearing metals are used in machinery with the object of limiting the friction between two or more contacting surfaces, a contact which is influenced appreciably by the motion of the particular part of the machine. The latter may be of simple translation, or circular, or oscillating, each of which will give different loading, pressure, and temperature effects. These bearing metals are often required to give a high resistance to pounding; those which become worn may fail by spreading or cracking, and thus a bearing metal which is highly efficient in one case may give a considerably reduced efficiency in another where the circumstances are, apparently, the same; bearing pressures and areas, and the temperatures involved, vary within wide limits, and each case must be considered on its merits,. As a general rule a good bearing metal is composed of hard grains effectively held in a relatively soft matrix with yielding characteristics, the hardness-yielding ratio requiring judgment and experience.

Obviously, bearing metal should be such that the inevitable wear takes place slowly, and, in the aggregate, be of small amount, conditions which require careful selection of metal, and systematic lubrication of the right kind. Its selection depends upon the kind and volume of work the particular bearing is required to do, and the production of a satisfactory white metal for Diesel engine connecting-rods has provided metallurgists and engineers with no mean problem. There is considerable variation in bearing pressures, the permissible limits, according to the metal used, varying from about 100 lb. for cast iron in journal bearings to over 2,000 lb. per sq. in. for steel on steel, according to quality. Whichever metal is used the primary consideration is its ability to stand up to the pressures to be imposed without strain or distortion. Both frictional and impact resistance values are important; if abrasion is to be absent, the hardest part of a bearing alloy must not be harder than the journal to be accommodated.

Anti-friction or white metals may be of a lead base or or tin base according to which forms the chief constituent. Lead, a most satisfactory bearing metal, requires the addition of a hardening alloy such as antimony, generally added in amounts up to about 13% according to the hardening quality required.

Copper base alloys give greater resistance to wear than either lead or tin base metals. With the high speeds and compressions common to Diesel engines, copper-lead alloy bearings may be preferable to white-metal linings, the weakest of which, under the conditions stated, may produce cracking and even disintegration; as a result of these increasing speeds and pressures in internal combustion engines, tin base alloys are being superseded by copper-lead alloys containing about 25% lead, which have much greater strength than white metals.

Many experiments have been carried out on the copper-lead-tin class of alloy for bearings. Lead alloys are generally satisfactory for lightly loaded bearings where high speeds do not obtain; the tin content should not be

less than 5%, and the remaining components adjusted to meet the particular load speed temperature factors. The melting point of tin, 232° C. may be raised by the addition of antimony and copper. Lead, in proper proportions up to about 10%, increases the resistance of a metal to deformation. Of the lead bronzes, an alloy of copper 70, lead 20, tin 5, and zinc 5, gives good resistance to wear. For high loads a nickel-bearing lead-bronze is generably suitable, and phosphor-bronze gives satisfactory service under heavy loads.

The effects of mould and pouring temperatures on these metals is important; for instance, the ultimate strength of a white metal is of less importance than the yield point, a value which may be substantially affected by pouring at low, or high, temperatures. With any metal bearing it is, of course, essential that the bearing housing be properly aligned and rigid, that proper clearance be provided, and that suitable lubrication, in order to maintain uniform conditions in the bearing working, be allowed for. With a correctly chosen metal, alloyed to the particular requirements, the ideal is most nearly attained by polished journals, regular and proper application of filtered lubricating oil, and protection of the bearings from dust and other unwanted components of the atmosphere.

Producing Small Vertical Oil Engines

Mechanised Plant at the Works of Ruston and Hornsby

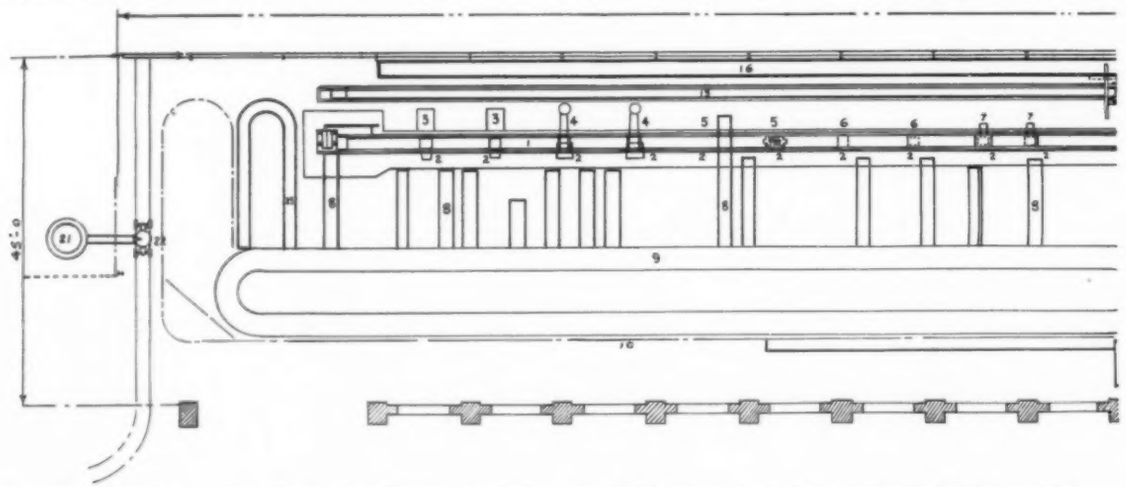
THE modern cold-starting oil engine has long passed its experimental stage, and is now used as a power unit in every industry, on all kinds of land and sea transport everywhere. This type of mechanical injection engine, now known as the Diesel engine, has evolved from the original British patents of Herbert Akroyd Stuart, of 1890, under which the world's first commercially-successful oil engine is claimed to have been manufactured at the Grantham Works of Messrs. Ruston and Hornsby, in 1892. So great has been the progress since that time, and so valued are these engines, from the points of view of reliability and economy, that these engines have earned a sound reputation for service.

This firm has specialised in the production of oil engines since that time, and to-day the works are modern in every respect. They include a modern foundry, forge, machine, erecting and test shops, a well-equipped boiler works, a laboratory where all materials are tested and a special shop for the manufacture of fuel pumps and atomisers. Recently a new self-contained section of the works has been erected especially for the production of small vertical oil engines. This new section includes machine shop, erection, test, painting and despatch, all under one roof. Entirely new equipment has been installed, and modern production methods have been instituted in order to maintain the high quality of the product at the lowest possible cost. Associated with this new section is a mechanised foundry which has been erected for the production of all the small castings.

This mechanised foundry section provides an example of the application of modern methods of a foundry producing a great variety of castings for a very wide range of products. The mechanised plant forms a self-contained section attached to the general moulding shop, and has its own sand-preparing and conveying plant, and its own cupola.

Fig. 1.—Moulding machine stations and closing operations.

The general layout of the plant is shown in the accompanying drawing, and it will be seen that an overhead belt delivers the prepared sand to 10 hoppers, where it is ploughed off by means of " V " ploughs operated from the



1. Overhead Sand Delivery Belt.
2. Hoppers.
3. Two British Moulding Turnover Machines.
4. Vogel and Schemmann Turnover Moulding Machines.
5. Two Tabor Squeeze Machines.
6. Two Hand Ramming Stations.
7. Two McNab Tabor Jar. Ram. Squeeze Machines.
8. Closing Roller Conveyers.
9. Plate Conveyer.
10. Overhead Casting Mono-rail.
11. Knockout Station.
12. Return Belt from Knockout.
13. Spillage Belt Conveyer.

Fig. 2.—Mould plate conveyer and casting operation.

floor ; Fig. 1 shows the arrangement. Under eight of the hoppers are installed the following moulding machines of the latest type : two British moulding turnover machines two Vogel and Schemmann turnover moulding machines , two McNab Tabor Jarram-squeeze machines ; and two Tabor squeeze machines.

The two remaining stations are utilised as hand-ramming stations for the oddments. After ramming, each half mould is placed on a short length of roller conveyer, cored and closed. Runner bushes, etc., are also put on here and the boxes clamped. The moulding boxes are all of the Sterling steel type, and particular care is taken to keep them in good condition to ensure accuracy and absence of twist. Furthermore, they are so much lighter than cast-iron boxes that fatigue is reduced, although more boxes are handled each day than is the case with floor moulding.

From the short lengths of roller conveyer the moulds are slid on to a plate conveyer. At this point the boxes are weighted, and then proceed on the plate conveyer to the casting station. This operation is illustrated in Fig. 2. It will be seen that specially-designed ladles are employed and are operated by one man with the aid of air hoists and an overhead runway. Ladles having a capacity of up to five cwts. are easily handled in this way. After the casting operation the moulds proceed on the conveyer to the knock-out station where they are pulled off. The sand drops through a floor grid, and returns to the sand-preparing plant via a cleaning unit consisting of magnetic separator, screen, and dust and silt extractor. It is worth noting that all sand is elevated by means of inclined belts, and not bucket elevators.

The moulding boxes are returned from the knock-out to the moulding machine by means of an assisted gravity roller conveyer. The castings are put on to a small slat conveyer and discharged into tubs which in turn are picked up when full by an overhead telpher, and taken to the fettling shop.

The sand-preparing and conveying plant was installed by Messrs. Augusts Ltd., of Halifax. It includes an underground sand-spillage belt conveyer, which is installed alongside the ramming stations, and links up with the belt conveying the knock-out sand. Sand from both these conveyers discharges on to an inclined belt leading to the cleaning plant which has already been mentioned. The cleaned sand is discharged on to a second inclined belt and taken to the storage hopper, shown in Fig. 3, over a No. 3 size August Simpson mill. The requisite quantity of cleaned sand is charged into the mill, and any new additions are added to the batch charge by means of a bucket loader. After mixing (three minutes) the one-ton batch of prepared sand is discharged from the mill into a hopper underneath, which has a rotary table feed, from which it is ploughed off on to a disintegrator. A continuous sand discharge on to the main sand-distributing belt is thus obtained. This arrangement gives the perfect milling associated with batch mixing together with a continuous and uniform discharge on to the belt.

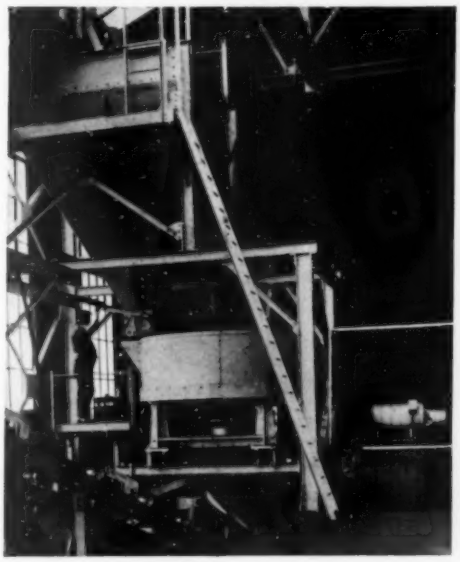
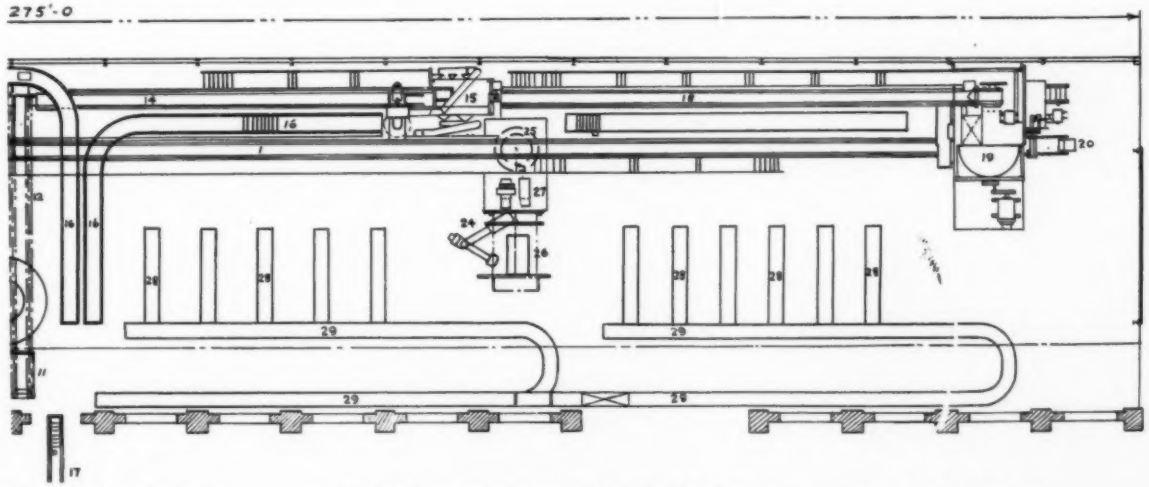


Fig. 3.—Sand storage hopper and an August-Simpson mill for sand preparation.



14. Inclined Belt to Cleaning Unit.
15. Sand-cleaning Unit.
16. Empty Moulding Box Return.
17. Slat Conveyer for Finished Castings.
18. Inclined Belt for delivering sand to Storage hopper.
19. No. 3 August-Simpson Mill.
20. Bucket Loader.
21. Cupola.
22. Ladle Receiver.
23. Roller Conveyer System for Special Metal Work.
24. Sand Slinger.
25. Storage Hopper.
26. Spillage Grid.
27. Elevator.
28. Closing Roller Conveyers.
29. Casting Roller Conveyers.

Fig. 4.—Close up view of discharge end of the rotary blast plant.

The molten metal is provided by a 3½-ton-per-hour cupola, which delivers into a ladle receiver from which the casting ladles are filled. This plant has now been successfully working for some considerable time, and regularly handles 20 tons of molten metal per day, producing green sand castings varying from one ounce to 2½ cwts.

For castings requiring special metals, a separate roller-conveyer system, horse-shoe shaped, is used. The moulds are rammed on an adjacent machine, and are cored, closed and cast on this roller conveyer. This arrangement allows for special metal brought from one of the cupolas in the main foundry to be cast in batches.

At the other end of the shop a sand-slinging plant has been installed. This plant can be used either for the larger sized green sand oddments, or for batch production of medium-sized work. The slinger is supplied from the main bulk sand ploughed off the overhead belt into a hopper. A spillage grid receives the spilled sand which is returned by means of an elevator to the hopper again. The moulds are finished, cored and closed on lengths of roller conveyer at right angles to the casting conveyer. This conveyer is on the same casting line as the main plant conveyer, and the same casting procedure is employed. Cast moulds are pushed up to the central knock-out station.

Castings from the mechanised foundry are taken by telpher crane to the section of the fettling shop which deals with light castings. They are tipped and placed on a belt conveyer feeding into a rotary-barrel shot-blast machine, by St. George's Engineers Ltd. This machine revolves at 3 r.p.m., and automatically discharges the castings at a rate of 2½ to three tons per hour, Fig. 4, thus enabling the grinders and trimmers to receive a clean casting. After fettling, all castings are inspected before being batched up for despatch, and all those that will not be in contact with oil are painted in the fettling shop before despatch. For this operation a dipping tank is used, and the castings are then ready for storage at the various works.

A well illustrated, well produced 60-page book issued by Thos. Firth and John Brown Ltd. details their many classifications of steels for modern purposes. The title is "Firth-Brown Steels, the Most Modern for all Purposes," and the introductory chapter traces the progress of the companies through their four generations in the steel industry, showing how reliability has been one of their basic qualities and describing their development of steel production by the crucible process, the Siemens Open-hearth process capable of producing ingots up to 200 tons weight, the adoption of electric steel manufacture including the more recent development of the high frequency induction furnace, hot working and heat-treatment, foundry facilities, and the scientific organisation or research laboratories which consider the whole of the various branches of science which can react upon, or be reflected in, the properties of steel under service conditions.

Influence of the Cooling Speed on the Transformation in Steels

A NEW method of investigating transformation processes at increased cooling speed, and the influence of the cooling speed on the transformation in carbon steels are discussed by Franz Wever and Adolf Rose.* Two former methods of investigating transformation processes at high cooling speeds are described and the advantages of the new method explained. It is based on curves of temperature plotted against cooling speeds, and obtained by an electro cardiograph governed by thermo-couples connected on the specimen, the beam being directed to a fixed sensitive plate. The blackening of the plate is measured photometrically, and it is explained in detail how the temperature-cooling speed curves can be developed from these figures. The new method has been verified by repetition of former investigations, and found thoroughly reliable.

The transformations of the carbon steels sink to lower temperatures almost discontinuously in three stages with increasing cooling speed. Therefore, the behaviour of carbon steels at increased cooling speeds can be described simply and clearly by three super-cooling diagrams.

The equilibrium diagram shows the transformation temperatures only in the ideal case of extremely small cooling speeds. It has to be replaced for a first range of cooling speeds by a super-cooling, diagram I. Here the pearlite temperature is let down to 650° C., and the proportion of eutectoid carbon is decreased to, say, 0·4%. The eutectoid separation of cementite is stopped to a large extent. Ferrite-sorbite to sorbite structure corresponds to this first super-cooling stage.

The second stage is characterised by higher cooling speeds. The pearlite temperature is decreased further to 500° C. ; the eutectoid concentration of carbon falls to about 0·35%. The austenite-pearlite transformation no longer takes a complete course, but is connected closely with the appearance of the third, the martensite stage, and simultaneously the structure turns from ferrite-sorbite over troostite-martensite to pure martensite. This transition takes place gradually in a wider range of cooling speeds at under-eutectoid and eutectoid steels, but very abruptly at super-eutectoid steels. The transition from equilibrium conditions to the three stages of super-cooling is marked by certain changes of the mechanical properties—e.g., hardness.

Canadian Mining Display at Glasgow Exhibition

Canada's importance as a producer of the metals that are widely used in industry and commerce is reflected in the display of Canadian mining specimens staged by the Department of Mines and Resources, Ottawa, at the Empire Exhibition, in progress at Glasgow, Scotland.

Visitors to the mineral exhibit in the Canadian Pavilion cannot help but be impressed by the diversity and scope of Canada's mining industry. The central feature of the display is a large map of Canada showing the six well-known physiographic areas or divisions, the location of commercial occurrences of metallic and non-metallic minerals, the geographic positions of refineries and steel plants, and railway and aerial transportation routes. On both sides of the map is a collection of coloured photographs of typical metallurgical and milling plants erected for the recovery of the various metal and mineral products. The next important feature is a display of large specimens of ores and minerals representative of the more important deposits that are being commercially developed in Canada.

Canada's position in the British Empire as a source of minerals is an enviable one ; she is the only producer of radium, the second-largest producer of gold, and holds first place as a source of nickel, zinc, lead, copper and asbestos.

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* *Mitteilungen aus dem Kaiser-Wilhelm-Institut fur Eisenforschung zu Dusseldorf*, Vol. XIX, issue 20, No.337.

Geological Development in U.S.S.R.

By Professor N. N. Gornostayev

Great progress has been made in recent years in the discovery and development of the mineral wealth of the U.S.S.R. Large stretches of formerly barren wastes have and are being developed as a result of rich deposits of minerals, and in this article the author surveys briefly the progress achieved.

THE vigorous development of geological science in the Soviet Union has created a new and impressive picture of this vast country, stretching over one-sixth of the earth's surface. Immense mineral wealth is being daily discovered by thousands of geologists, who, in their prospecting work, travel over sand-baked deserts, huge wild mountains, over the big spaces of the southern steppes and the boundless forests and tundras of the North.

The Union possesses sufficient resources of the whole of the 92 chemical elements which comprise the Mendeleyev Periodic System. Soviet deposits of such important minerals as coal, iron, oil, potassium, manganese, peat, phosphorus and gold are probably the largest in the world.

In 1913 the total known coal deposits of Russia comprised but 3·2% of the world's resources, as estimated by the Twelfth International Geological Congress. At the Seventeenth Congress, held in Moscow last year, the estimated coal resources of the Soviet Union, according to incomplete data, were found to be seven times greater, or nearly 21% of the world's coal reserves. In addition to the Donetz Coal Basin, which yielded 87% of the coal mined in Russia in 1913, large coal deposits have been discovered in Kazakhstan, Siberia, and in the Far East. The coal deposits of the European part of the Union now comprise but 9·1% of the country's total resources. This more equitable distribution of the coal reserves makes possible widespread industrialisation throughout the entire country, even in the most outlying regions.

The iron ore deposits of the Union are now known to be five and a-half times greater than they were estimated to be in 1913. The reserves of oil, which supply the automobile industry, aviation and shipping with fuel, are now 14 times greater than in 1905. Oil deposits have been found along the entire Ural range, and geologists are now prospecting for oil on the vast Siberian plains. According to the calculations of scientists, it is possible that the soil of Siberia contains some of the richest oil deposits in the world. Incidentally, it is considered that Siberian oil is also the oldest in the world.

It has now been established that more than 83% of the world's known resources of potash are concentrated in the Union, and these resources are being steadily augmented by ever new discoveries. More than 73% of the world's manganese ore reserves are to be found in the U.S.S.R. Huge deposits of apatites, discovered on the Kola Peninsula, have doubled the world's resources of phosphorus, a basic fertilizer.

The U.S.S.R. holds second world place in respect of gold output. The gold industry, which had formerly employed the most primitive methods, has now been largely mechanised. Not infrequently gold prospectors unearth nuggets weighing several kilograms. A huge nugget of gold, weighing 32 kilograms, was found in the Miass Lenin goldfields in the Urals in February of last year. Two pieces of the nugget, which broke while being extracted, weighed 14 and nine kilograms, respectively, and were of the finest crystallized structure. Together with the crystalline gold nugget of more than 36 kilograms, found in 1842 in the same district, and a number of other nuggets, these two pieces have been added to the Soviet collection of precious stones and rare geological finds.

Hitherto desolate Kazakhstan—roving ground for nomadic tribes—is now the main Soviet source of supply of non-ferrous metals: copper, zinc and lead, and has far outstripped the Urals, the old source of these metals. Until recently, this country was lacking in boron. Huge deposits of boracic salts in the district of Lake Inder in north-western Kazakhstan have now been unearthed.

The stream of new discoveries in all branches of Soviet geology is so vast that there has not been time to grasp it properly and to make a theoretical summary of it on a sufficiently large scale. The first and most important task confronting Soviet geology is to make such a summary in order to facilitate the placing of this immense mineral wealth at the service of the people.

Geological Structure

The geological structure of the Soviet Union is exceptionally varied. On its territory are huge mountain folds which have risen on the site of former sea depressions, filled with soft layers of clay, sand and lime (the Caucasus, for example); there are mountain crags which are the fragments of ancient rough and hardened rocks split into uneven blocks, some of which soar upwards, and others point downward (the Tyan-Shan, Altais and others); then there are deep depressions such as Lake Baikal (the largest fresh-water lake in the world, and more than 1,520 metres deep), or the Black and Caspian seas.

Where once soared the great Ural mountain range, equalling the present Alps or the Rockies, now spreads a plain hundreds of kilometres wide, forming the western part of the Siberian lowlands. The Urals of to-day are merely the western tail-end of the great range of ancient times and, moreover, were elevated a comparatively short time ago.

Only a relatively short time ago, by geological reckoning, the Crimean mountain range was as immense as the Caucasian. But split by enormous clefts, it sank down to a great depth, and now lies underneath the bed of the Black Sea at a depth of more than 2,000 metres. The Crimean mountains of to-day are merely a fragment of the northern slopes of the ancient mountains. Mighty earthquakes and at times terrific volcanic eruptions accompanied the formation of these mountains, the processes being to a great extent still clothed in mystery. At present, geologists are working on the tabulation of all geological formations of the earth's crust encountered in the U.S.S.R., with a view to establishing a consistent theory of mountain formation, of course, taking due account of all the work that has amassed on this subject in the west. The variety and complexity of geological structures explain also the variety of the igneous rocks in this territory and the remains of cooled lava within the crust of the earth or on its surface due to volcanic eruptions. Practically all the known varieties of erupted or igneous rocks have been found in the U.S.S.R. Many exceedingly rare rocks found in large masses have so far not been discovered anywhere else. Particularly remarkable are the rocks of the Khibiny Mountains on the Kola Peninsula. Kirovsk, a large industrial centre, has sprung up in the course of a few years for the exploitation of the minerals found in these rocks.

Entire mountains of sodic sanidinites, which, up to now, were known only in the form of separate lumps of volcanic ejecta, have been found in Kazakhstan. Soviet scientists have been able to make a thorough study of the formation of this rock. A comparative study of igneous rocks has made it possible to place them in formations in the order of their natural relation to one another, and it is intended

shortly to summarise the new theories on the origin of these complex formations.

A study of the mineral springs of the U.S.S.R. has made possible considerably to extend the health resorts, some of which are being opened not only in the world-famed Caucasian mineral spring district (which, by the way, has been greatly enlarged), but also in various other parts of the country, including the Trans-Baikal, Yakutia and in the Far East. It is interesting to note that even on the territory of Moscow itself mineral waters containing bromine, radium and many other health-giving substances have been found, the utilisation of which is being contemplated.

With its valuable mineral resources the Union is a splendid field for the development of geological science. Soviet geo-chemistry is flourishing as never before. Discoveries of the most diverse valuable minerals, especially during the Second Five-Year Plan, are largely the result of geo-chemicoal prognoses which are being made with increasing accuracy and confidence. All the achievements of Soviet geology, particularly in its practical application, are based on geological forecasts. It was on the basis of such planned study that geological structures resembling oil-bearing strata have been found underneath Moscow itself.

The study of marl alluvium, such as unconsolidated gravel, sands, clays and others, is making rapid headway in the U.S.S.R., particularly in connection with the building of huge structures and hydro-technical projects. The theoretical summarisation of the original results obtained by Soviet engineering geology and hydro-geology during the construction of the Palace of Soviets, the Moscow Metro, the White Sea-Baltic canal, the Moscow-Volga canal, and other structures, has made it possible to plan such large-scale undertakings as the sluicing of the Volga, and the irrigation of the arid steppes of the Trans-Volga region.

Behaviour of Welded and Bolted Rigid Joints under Static and Alternating Bending Strain

THE purpose of a recent investigation, by Friedrich Koerber and Max Hempel,* was to determine the course of the deformation stresses and of flow phenomena of welded and welded-and-bolted rigid joints, respectively, and to find out the fatigue strength of these parts under alternating bending strain at various mean strengths. After a survey of the extensive literature the test pieces, the testing apparatus, and the measuring instruments are described, and the results of the experiments are given in graphical and tabular form. They may be summarised as follows: The welded joints show inconsistencies of elongation, especially on the edges of the top and bottom flanges, which may be caused by locally limited peaks of stresses at the welding points. The elongation figures are dependent on the shape of the test-pieces, as well as on the working point of the load.

In order to facilitate the observation of the lines of flow which show the excess of the limit of extension, the test-pieces are painted with lime which drops off where permanent deformations occur, and very instructive pictures could be obtained.

Where rolled girders have been welded to a solid plate fatigue tests of joints have given alternating stresses which could be increased up to fracture at the welding points; this was impossible at test-pieces of welded and bolted joints. In these cases fatigue fractures of the bolts occurred before any destructions of the welds could be recognised.

* *Mitteilungen aus dem Kaiser-Wilhelm-Institut fur Eisenforschung zu Dusseldorf.* Vol. XIX, issue 19, No. 336.

The James F. Lincoln Arc-Welding Foundation

The papers submitted in the $200,000 Award Programme of The James F. Lincoln Arc Welding Foundation are being judged at Cornell University, Ithaca, New York, by the Foundation Jury of Award, which convened recently. Thirty jurors from engineering departments of various colleges and universities will judge the entries under the direction of Dr. E. E. Dreese, of Ohio State University, chairman of the Jury of Award. To assist in properly appraising the merits of any paper, the Jury of Award will consult experts or outstanding authorities in the various classifications of the Award Programme.

The Jury of Award in session studying the papers submitted.

In judging the papers the Jury of Award will be evaluating original studies conducted by engineers, designers, architects and others over a period of 15 months between the announcement and close of the Foundation Award Programme. The subject studied during the period was the application of the arc-welding process of construction to the design of all types of products and structures. The mass of accumulated data, being for the most part in new fields of design will, therefore, be a valuable addition to engineering knowledge. Evaluation of the studies will be on the basis of benefits accruing to industry and to mankind in general from application of this industrial process. Rewards for the studies will be in 446 individual amounts ranging up to $10,000, with the Grand Award of $13,700.

Hydrogen Brittleness of Carbon Steels

AN investigation on the hydrogen brittleness of steel was published in 1934*. Following this work the authors, Peter Bardenhener and Heinrich Ploum, carried out experiments on steel wires† of 0·07%, 0·35%, 0·63%, and 0·86% carbon contents, but, for the rest, of the same analysis. These wires had passed through processes of hydrogen absorption by electrolysis as well as by heating in an atmosphere of hydrogen under various conditions. The brittleness was then examined by bend tests.

In the case of electrolytic treatment the fracture exhibited a circular flaky zone the width of which depended on the duration and the degree of the process of absorption.

The change of the mechanical properties as caused by the hydrogen absorbed by the steel wires was partly reversed when the hydrogen was released from the steel by storing the material, but the original state could not be recovered. Even if the hydrogen was removed completely the material was spoiled to a certain extent which depended on the degree of the former hydrogen contents.

* See *Mitteilungen aus dem Kaiser-Wilhelm-Institut fur Eisenforschung zu Dusseldorf.* Vol. XVI, pp. 129/136.

† *Mitteilungen aus dem Kaiser-Wilhelm-Institut fur Eisenforschung zu Dusseldorf.* Vol. XIX, issue 21, No. 338.

American Society for Testing Materials

The Forty-first Annual Meeting

Technical features of outstanding interest included a symposium on impact testing, and the effect of temperature on metals.

WHILE there is no single factor by which to judge correctly the significance and success of the recent annual meeting of the American Society for Testing Materials, held in Atlantic City, there are certain items which do indicate the activity of this society in its work involving standardisation and research in the field of engineering materials. It is significant, for instance, that 72 new specifications and tests were published for the first time as tentative. Attendance at the meeting is a criterion of interest in materials work ; 1,138 members attended, and the 17 sessions devoted to papers and reports were well supported. Over 100 papers and reports were presented, certain of the technical features were of outstanding interest, including a Symposium on Impact Testing, and the effect of temperature on metals.

Presidential Address

In his presidential address, Dr. A. E. White, discussed organised research, pointing out the extreme importance of the society's activities in this field on the questions of both methods of testing, and on the properties of materials, and discussed research activities under general groups, including individuals, corporations, associations, testing laboratories, Government bureaux, councils, foundations, societies, research institutes and colleges and universities. Research, he said, is one of the keystones upon which further world progress depends. It enters into the field of agriculture, communication, transportation, public health, energy, and the production of industrial products. There is a definite interlocking of all of these groups. Each one is dependent for its prosperity and advancement upon the others. All must look to research as one of their foundation stones. The findings of research are needed for continued progress and prosperity. No field is an exception. Sponsorship of research, therefore, must, and will, be continued at an ever-accelerating rate. Every encouragement, therefore, should be given to those individuals and agencies engaged in research so that, through their achievements, research may contribute its share in restoring prosperity, improving standards of living, and adding to our store of cultural values.

Marburg Lecture

The thirteenth Edgar Marburg Lecture on " The Torsion Test," by Dr. Albert Sauveur, attracted a large audience. In the lecture, he described a specially-built torsion machine, and stressed the utility of the torsion test. He pointed out that it yields valuable data which, in general, the tension tests do not provide. Certain points which seemed significant were Dr. Sauveur's emphasis on the simplicity of torsion machines, and the ease of making the test ; also the significance of hysteroses resulting from reverse twisting. Definite evidence in the form of curves showing steps in slip was of interest to all present.

1938 Award of Dudley Medal

The 1938 award of the Charles B. Dudley Medal was made to R. H. Heyer, member of the research department, the American Rolling Mill Company, for his paper presented at the 1937 annual meeting on the subject, " Analysis of the Brinell Hardness Test." This paper was considered the outstanding original contribution to research in engineering materials, of those given at the last year's meeting.

TECHNICAL REPORTS AND PAPERS

Special interest at this meeting was given to the ferrous metals fields, and included steel, ferro-alloys and corrosion, iron, and the effect of temperature and fatigue. Nine revisions of existing ferro-alloys standards, in the form of new tentative specifications, were submitted, which will supersede the existing standards when adopted. These cover spiegeleisen, ferro-manganese, ferro-silicon, ferro-chromium, ferro-vanadium, molybdenum salts and compounds, ferro-molybdenum, low-carbon ferro-molybdenum and ferro-tungsten. The new specifications are in closer agreement with commercial practice and requirements, and provide in some instances for additional grades. It is believed that these new standards will be of considerable utility. Additional work on ferro-boron and ferro-titanium and ferro-columbium is in progress.

New specifications were offered for normalised quenched-and-tempered steel forgings, and seven existing specifications were proposed for adoption as standard covering : Structural nickel steel, seamless cold-drawn alloy-steel (4% to 6% chromium) heat-exchanger and condenser tubes, and still tubes, carbon-silicon-steel plates, chrome-manganese-silicon, and molybdenum-steel plates for boilers and other pressure vessels, and cold-rolled strip steel, and a number of revisions in several standards were also recommended. New specifications were also proposed covering lap-welded and seamless-steel-iron boiler tubes which will eventually replace the existing standard and new specifications covering medium carbon and carbon-molybdenum seamless steel boiler tubes, and spiral welded pipe. Changes were proposed in two existing specifications for electric-fusion-welded pipe, providing requirements for spiral pipe made by the electric-fusion-welded process.

Tests made to obtain information on the load-resisting properties of four low-alloy high-strength steels and one ordinary structural carbon steel when subjected to static, impact, and repeated loads, were reported on by Professors Collins and Dolan. The results indicate that two of the low-alloy high-strength steels had considerably higher rates of yield point to tensile strength than ordinary structural carbon steel, and had about the same ductility as the latter. The chemical compositions for these two steels are as follows : (*a*) carbon, 0·08 ; manganese, 0·27 ; phosphorus, 1·45 ; sulphur, 0·020 ; silicon, 0·80 ; copper, 0·41 ; chromium, 1·01 ; (*b*) carbon, 0·08 ; manganese, 0·43 ; phosphorus, 0·104 ; sulphur, 0·022 ; silicon, 0·162 ; copper, 1·07 ; nickel, 0·54. All steels had well-defined yield points. The properties obtained from the impact tests apparently depend upon the type of specimen used. For repeated load specimens free from abrupt changes in section and tested in air, all four low-alloy high-strength steels had endurance limits at least 67% greater than that of structural carbon steel. However, the low-alloy high-strength steels exhibited a greater fatigue notch-sensitivity, and were damaged to a greater extent by corrosion-fatigue than ordinary structural carbon steel.

Effect of Temperature on Fatigue of Metals

Much interest was shown in the work on the effect of temperature on metals, especially elevated temperatures involving creep. A rather voluminous report on the effect of temperature was presented outlining results of numerous investigations in progress. One of the projects which should be of great value is the volume on creep data, which is soon to be published. This gives extensive information and data developed by the committee covering a wide range of carbon and alloy steels, irons and some non-ferrous metals. Work on creep-test of tubular members subjected to internal pressure indicated that under certain conditions a pressure vessel may decrease in length during service, and under other conditions may increase in length substantially at the same rate as the diameter increases.

A final report on long-time creep tests of a 0·35% carbon steel involving a test duration of 22,438 hours indicated that the extrapalation from the 2,000-hour period was conservative, as compared with actual deformation over 20,000 hours. Other reports covered investigations to ascertain whether an agreement in creep results could be obtained by different laboratories using the society's tentative methods for long-time tension tests, and report on the acceptability tests for high temperature chacteristics. A progress report on the effect of manufactured variables on creep resistance indicated a decided superiority of creep resistance at 750, 850 and 950 F., for coarse-grained plain carbon steel over fine-grained plain carbon steel.

There was a great deal of interest, evidenced by discussion, in the paper presented by S. H. Weaver of the General Eectric Company on "Actual Grain Size Related to Creep Strength of Steels at Elevated Temperatures." The paper was based on a statistical analysis of 32 creep tests made on S.A.E. 4330 steel at a creep temperature of 840 F. The author concluded that there is an optimum grain size for the maximum creep stress, and that a larger or smaller grain than this gives decreasing stress for the particular steel and temperature. It was reported that grain size may change the creep strength by 21,000 lb. per sq. in., and that the structure within the grain can change the creep strength by 4,500 lb. per sq. in. Several authorites in this field discussed the paper critically. A number commented on the present situation with regard to grain-size terminology, it not being clear to those in this field when the various authors used the term austenitic size, carbide grain size, actual size, etc. One member indicated that if the specimens of 32 steels had been given the same time and temperature of heating that creep specimens had been given, and the austenitic grain sizes determined on them, information on grain-size correlation would have been more valuable. Still another authority indicated that while creep stress of a given steel is associated with its grain sizes, mode of distribution of carbides and stability of this distribution during the tests are factors to be considered, and other factors may play a rôle.

Professor J. B. Kommers discussed "The Effect of Overstressing and Understressing in Fatigue," giving data obtained after the application of various cycles at 10, 20, 30% over stress. He concluded that the endurance limit of a material is not a fixed quantity since various methods affect it. Periods of cyclic overstress quite commonly reduce the endurance limit, while periods of progressively increasing cyclic understress may greatly increase the endurance limit.

An abstract of an extensive paper outlining "Recent Developments in European Research on Fatigue of Metals,' was given by R. P. Seelig. This paper presents data on testing methods, results, and theories developed in European laboratories. More and more, fatigue experiments in Europe are carried out with shaped parts rather than with special specimens. The paper discusses in detail fatigue as related to welded joints, the effects of corrosion fatigue, and the very important influence of surface condition of parts under repeated stress.

Radiographic Testing

A session was devoted to radiography at which four papers and a report were presented on radiographic testing. In presenting the report, Dr. H. H. Lester pointed out that radiography is widely used, and that notwithstanding certain misunderstanding and some incorrect applications in the work, especially in the early years, it has become so important in industry that the society has set up a new standing committee devoted to its interests. Radiography is not merely a method of testing, it is a device that makes possible the utilisation of more economical methods of fabrication of highly responsible structures, but more important than that, it fills an essential need in industrial evolution in that it makes possible the reasonable assurance of dependable service in the structural units of our modern mechanised society. Up to now, radiography remains as the most generally practical method of non-destructive testing.

Dr. H. E. Seemann discussed a problem which is very important in radiography, namely, the effect of secondary radiation upon the quality of a radiograph. He also covered the principles of measurement and results of experiments to determine the amount of secondary radiation in the radiography of common industrial materials. Thicknesses were limited to those which can be conveniently radiographed without fluorescent intensifying screens. The principal conclusions to be drawn are: (1) That lead screens may remove nearly one half of the secondary radiation recorded when no screens are used, and (2) that no important reduction in secondary radiation is possible by adjustment of the kilovoltage within the range it is necessary to use for a given subject. The experiments must be considered as a mere introduction to the study of this important problem in radiography, the author stated, and that further investigation is contemplated with the hope that future results may contribute not only to our knowledge of the subject, but to improvements in radiographic technique.

In a paper on "A Study of Intensifying Screens for Gamma-Ray Radiography," Messrs. Briggs and Gezelius pointed out that it has been known for many years that a reduction in exposure time in gamma-ray radiography can be obtained, if materials which fluoresce upon exposure to the rays are kept in intimate contact with the film during the exposure. Calcium tungstate has been found to be the most efficient intensified for both X-rays and gamma-rays. However, tests made at the time the original studies on gamma-ray technique were conducted indicated that the calcium tungstate screens available at that time did not possess enough advantages, when compared to lead screens, to warrant their use. Since that time there has been considerable improvement in the calcium tungstate screens available for radiography. It was deemed advisable to study several commercial screens in an attempt to improve the technique now used in gamma-ray radiography. Six different sets of intensifying screens were obtained for the work.

The authors concluded that calcium-tungstate intensifying screens show considerable variations among themselves. Each screen studied had different characteristics. The sensitivity recorded by using the calcium-tungstate screens was inferior to that of the lead-foil screens. Also the longer the exposure the poorer the definition due to the fogging or clouding over of the defects by the fluoroscopia effect retained by the screens. As calcium-tungstate screens are limited to comparatively short gamma-ray exposures on thin sections, and the wave length of the gamma-ray makes it unsuitable for use on thin sections, it appears that these screens are at the present time useful only in cases where good sensitivity and contrast are not required.

Impact Testing

Of outstanding interest was the symposium on Impact Testing, comprising eight technical papers with extensive discussion. This symposium was developed by Mr. W. W. Werring and Professor M. F. Sayre. Two sessions were devoted to the symposium. At one session present fields of commercial use for the impact tests were stressed, with particular reference to places where the impact test gives necessary information not supplied by static tests. At the second session, the basic theory underlying impact testing was under discussion. Intentionally, all discussion of the relative merits of specific specimens of the differing types of impact machines now in use was suppressed in favour of the two questions mentioned.

Messrs. G. C. Riegel and F. F. Vaughan reported upon the success their company had had in reducing the failures of gears, caterpillar tracks and other parts over a period of years through the development of steels of progressively higher and higher impact strength values, the shape of the

parts themselves and the ultimate strength, hardness and ductility of the material used being retained essentially unchanged. The impact test was here used not only as a measure of the resistance of the metal to sudden blows, but also to measure the likelihood of brittle failure under normal static loading at notches or points of stress concentration.

To check on possibilities of added brittleness under severe winter conditions, occasional tests at very low temperatures are made. Occasionally, where ordinary tests leave doubt as to the acceptability of a material, supplementary impact tests on double-width specimens with intensified notch effects are made. If the foot-pound values of the double specimens are less than double that of the single width specimens, the heat is not accepted.

The use of varying methods of impact testing, each one devised to meet specific needs, in cases where the ordinary standard methods of impact testing could not be used, was urged by Mr. Sam Tour. He described a number of cases where this has successfully been done. Mr. W. H. Bruckner described work done at the Naval Research Laboratory, at Annapolis, on studies of weldability of steels, in which small test coupons of various steels were given heat-treatments simulating those which occur naturally to the steel immediately adjacent to the line where a weld is being deposited. These coupons were then tested in impact, and compared in properties with similar coupons not heat-treated.

The outstanding paper at the second session was one by Messrs. D. J. McAdam, junior, and R. W. Clyne, on "The Theory of Impact Testing: Influence of Temperature, Velocity of Deformation and Form and Size of Specimen on Work of Deformation." This paper emphasised the fact that notch impact testing was primarily a method of testing for potential brittleness in a material under all types of service, rather than a method of testing for resistance to effect of sudden blows, the notch acting to intensify any tendency towards brittleness which might be present in the same way as would lowered temperature or to a lesser degree, higher velocity of blow.

A paper from Prof. N. Davidenkov of Leningrad, emphasised that it was often much more important to determine how large a change in conditions would be required to produce sudden increase in brittleness, than it was to know what the ductility of energy absoption was numerically under the test conditions themselves. As a quantitative "brittleness factor," he recommended the use of a ratio obtained by subtracting the temperature at which cold brittleness appears in standard impact tests, from room temperature, and dividing by the room temperature in degrees absolute. This gives an equation identical in form to the familiar Carnot cycle equation, but applied to an altogether different purpose.

Equipment of Wire Rope Works

WIRE rope is such a useful commodity that its uses are continually expanding, and cannot be adequately enumerated here; the advantages which have led to its extensive use are the results of either or both of its two important properties—namely, its strength and flexibility. A large number of variables appear in connection with both the construction and the use of ropes, but here it is proposed to discuss briefly the equipment involved in the manufacture of wire ropes, and to cite as an example the works of Messrs. Glover Brothers (Mossley) Ltd., where the manufacture of wire rope was established in 1906. From the first, the layout of the factory was such as to ensure the economical production of a high-class article, and the firm soon built up a considerable business in the production of colliery ropes. During the war period a large proportion of the output of the works, comprising mine-sweeping ropes, submarine net cords, mine-sinker ropes and aerial ropes was absorbed by the Government, no less than a million feet of aeroplane cable being supplied each month.

Bobbins with the wire swifts arranged in front.

The works to-day represent the latest practice in layout and equipment for the manufacture of steel-wire ropes. A feature of the factory equipment is the use of the individual electric drive for the operation of wire-rope closing machines, stranding machines, bobbins and swifts, etc., the driving motors and control gear having been supplied by The General Electric Co., Ltd.

Among the many types of ropes manufactured by Glover Brothers may be mentioned the highest qualitities of plough and patent steel-wire ropes for colliery winding and haulage, in locked coil, flattened strand and the more general constructions in Langs and ordinary lay; colliery guide rods in locked coil, round rod mild steel and Swedish charcoal iron, galvanised flexible steel wire ropes for trawls and general shipping purposes, flexible ropes for cranes, hoists and general engineering purposes, aeroplane cables and flexible cords for all purposes.

Wire rope is made with different numbers of strands and numbers of wires to the strand, according to the purpose for which it is to be used. Round ropes are usually composed of a number of wire strands twisted round a hemp core or round a wire strand or wire rope, standard wire rope being made of six strands placed round a hemp core. The hemp is usually saturated with a lubricant, and although providing a little additional strength, it acts as a cushion to preserve the shape of the rope, and helps to lubricate the wires. The numbers of wires commonly used in the strands are seven, 12, 19, 24 and 37, depending upon the

A 20-ton closing machine for wire rope manufacture, driven by a 20-h.p. G.E.C. slipring motor.

flexibility required, but there are numerous variations in making up the strands.

Raw material, consisting of coils of plain steel wire, is received at the works and weighed, after which it is passed to the receiving warehouse which adjoins the test-room. For testing purposes there is a complete range of Denison machines, which test up to 12,000 lb. per sq. in., and also a Goodbrand machine for testing the finest wires. All wires are subject to rigid test before passing into stock. After testing, the heavier wires are passed direct into the first bay of the mill building, where they are graded and stacked as to size and quality, the finer wires being housed in a separate storeroom.

The main building consists of four equal bays: the first, as already stated, is devoted to a stock floor. The second bay of the mill, shown in Fig. 1, is arranged with groups of machines for transferring the wire from the coils to spools. A 25-h.p. 400-volt squirrel-cage motor drives the line-shafting for the bobbins, the swifts containing the wire coils being arranged in front of the bobbins. The two remaining bays are occupied with a range of electrically-driven stranding machines. There is quite a range of stranding machines, one of the 19-wire stranding machines in the main stranding department is driven through gearing by a 12½-h.p. slipring motor running at 960 r.p.m., while seven-wire stranding machines are each driven by a 7½-h.p. slipring motor through gearing.

After stranding, the material passes forward into the closing shop where ropes are made from $\frac{1}{16}$ in. up to 2½ in. diameter, and range up to 200 tons breaking load. Fig. 2 shows a 25-h.p. slipring motor driving the 20-ton closing machine, and at the back of the same illustration is also seen a six-ton closing machine, which is driven by a 15-h.p. motor. The heavy wire ropes after leaving the closing machines are coiled direct on to bogies ready for despatch, thus eliminating a further handling of the material.

A special feature of the closing shop is the guide-rod machine. The wire for the guide ropes is given an exceptionally long lead in the closing, so as to take out all bends and cleats. Ropes up to 2½ in. in diameter and 20 tons in weight are closed upon this machine. We are indebted to Messrs. Glover Bros. (Mossley) Ltd., for permission to publish this information and illustrations.

THE new 180-page catalogue issued by J. W. Jackman and Co., Ltd., Foundry Engineers, Manchester, is sectionalised and thumb-indexed for easy reference to the seven main groups of products. These are: Melting appliances, sand machines, moulding machines, core-shop ovens, jolters, and other equipment, sand-blast machines, air compressors and appliances and metal-testing machines.

The catalogue is completed by two and a half pages of useful tabular information for foundrymen.

Fatigue Testing of Steel Wires under Varying Tensile Strength

The failure of heat-treated wires in cables for the Mount Hope and the Ambassador Bridge, in U.S.A., induced A. Pomp and Max Hempel to carry out an investigation on the influence of wire manufacture on the repeated tensile stress. The investigation* was based on former experiments made by A. Pomp and C. A. Duckwitz in 1931.

Two steel wires of the same analysis and of almost equal tensile strength, one in drawn-patented, the other in tempered condition, were subjected to fatigue experiments under repeated tensile strengths, in air as well as under water spray. Details of the properties of the two wires are given, the construction of the testing machine, etc., is described, the methods of calibrating and working of the testing apparatus are explained and the conditions and results of the experiments are reported.

Fatigue tests on wires in the as-delivered condition proved that the method of production has no influence, and the gradients of the alternating stresses used showed that the alternating strengths are almost independent of the mean strength. The decrease in repeated stress in connection with corrosion tests was found to be 45·5% for both kinds of wire.

If the steel wires were deformed by bending before the fatigue tests, the repeated stress decreased and the fatigue corrosion stress was about a third of the repeated stress of wire bent previously in the same manner, but tested in air.

If the deformation of the steel wires is produced by torsion the tempered wire gave less favourable results than drawn-patented wire; the extent of the additional deformation by torsion did not seem to be without influence on the repeated stress.

An apendix of this publication contains some remarks on the influence of speed during torsion tests of wire. The two wires of the main investigation showed a completely different behaviour; no influence of the varying speed could be found for the tempered wire, but the number of torsions before breaking increased for the drawn-patented wire all the more than the speed of the torsions decreased. Various experiments have been made in order to clear up this problem; but before definite conclusions can be drawn, results of further tests are awaited.

Conveyers for Industrial Use

As no two industries—indeed, no two plants in one industry—present quite the same problem as far as conveyers are concerned, each installation must be planned and designed for its particular duty. Hence, a successful conveyer system must be composed of standard parts that are flexible enough to be adapted to any requirements. This flexibility is possessed in a marked degree by the Fraser and Chalmers "Webb" conveyer system, which can be employed efficiently for transportation, storage, processing and assembly work in all branches of industry.

"Webb" conveyers, which are now manufactured in this country by Fraser and Chalmers Engineering Works, were originally developed for the automobile industry, and they now enable the efficiency and low production costs that are characteristic of modern automobile factories to be obtained in a large variety of other industries. Every part employed has been tested in a large number of actual operations, and its service value fully established; this is proved by the invariable success of the many installations, which in conjunction with those of Fraser and Chalmers' American associates (The Jervis B. Webb Conveyer Co., of Detroit) aggregate more than one million feet of conveyer. In fact, many features that are now generally accepted as standard in the industrial conveyer world were originally developed for the "Webb" conveyer system.

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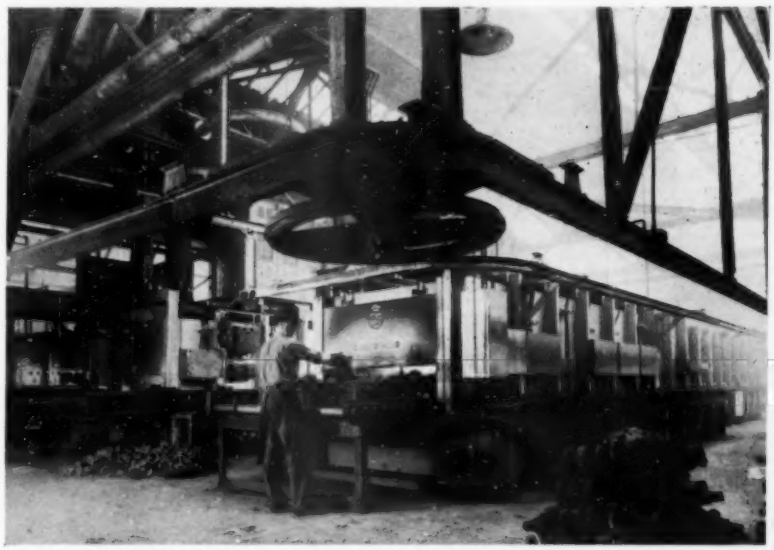
* *Mitteilungen aus dem Kaiser-Wilhelm-Institut fur Eisenforschung zu Dusseldorf*, Vol. XIX, issue 17, No. 354.

Heat-Treatment of Copper-Silicon Ferrous Castings

In certain manufactures mass production is of primary importance, consistent with quality, and plants can be specially designed to deal expeditiously with particular components. This is especially true of heat-treatment operations, and is emphasised by the furnaces installed at the Dagenham works of Ford Motor Company for the treatment of copper-silicon alloy castings, brief particulars of which are given in this article.

THE importance of the new copper-silicon alloys in engineering cannot be said, as yet, to be by any means fully demonstrated. Normally, the composition of these ferrous alloys is carbon 1·35—1·60%, manganese 0·5—0·6%, silicon 0·85—1·10%, chromium 0·4—0·5%, copper 1·5—2·0%, with sulphur and phosphorus very low; the breaking strength is in the neighbourhood of 60—65 tons per sq. in. The main application of this material, at present, is in the motor-car industry, and great credit is due to Ford Motor Company Limited, Dagenham, for their pioneer work in this field. This company already employs large quantities of copper-silicon alloy castings for crankshafts, brake drums and other automobile and tractor components, and their experience leaves no doubt but that, as the casting technique for this material advances, its applications will expand to an extent which it is almost impossible to predict.



Three electric Furnaces installed at Ford Works at Dagenham for the treatment of copper-silicon castings.

The main characteristics of the copper-silicon alloy are:

(*a*) It has better wearing properties than malleable iron.
(*b*) The tensile strength is higher than for malleable iron.
(*c*) It has shock-resisting properties superior to those of steel.
(*d*) Components may be produced by casting which previously required steel forgings.

The advantages consequent on the above characteristics will be obvious and, in particular, the reduction in the amount of scrap as compared with forging practice—scrap, produced both in the forging and in the subsequent machining processes—is of great importance in quantity production on the scale involved at the Ford works.

The realisation of these advantageous properties of copper-silicon alloys, however, depends upon correct heat-treatment of the material. In this heat-treatment, therefore, considerable accuracy is required, and completely consistent results must be produced to take advantage of the full, potential saving in scrap.

For these reasons Ford Motor Company Limited have installed three large electric furnaces which have been built by Birmingham Electric Furnaces Limited. This installation is probably the only one of its kind in the country, and therefore has considerable interest even apart from the importance of the applications with which it is concerned.

Before describing the furnaces themselves it is, perhaps, convenient to indicate the requirements of the work. The copper-silicon alloys require a double treatment sometimes referred to as "hardening" and "annealing." The former operation comprises heating the stock to about 1700° F., holding it at that temperature for a predetermined time, and thereafter cooling it rapidly to about 1,100° F. The second part of the treatment consists in reheating to about 1,400° F., followed by controlled cooling. The result of this treatment is to give the material a Brinell hardness of about 350, and to bring out its excellent wear-resisting and shock-resisting properties in full.

The three furnaces installed at the Ford works for these treatments are, for convenience, designated A, B and C.* Furnace A is used for the first or "hardening" treatment, furnace B for the second or "annealing" process, while furnace C is arranged to carry out "hardening" and "annealing" consecutively, in one equipment, on certain components. In each furnace the appropriate time-temperature cycle is established automatically, but, apart from the different heat-grading necessary for this purpose, all three equipments are of similar mechanical design and construction.

All three furnaces are of the conveyer type, the work being carried through each furnace, from end to end, automatically and continuously. The conveyer itself comprises a series of closely-spaced rollers mounted transversely across the furnace chamber and rotated by mechanism outside the furnace. The castings are loaded in special grid-type trays of nickel-chromium alloy which are carried forward by the rotating rollers, passing in a continuous stream, two trays wide, through the furnace chamber.

The rollers in the heated part of the furnace, needless to say, are constructed of nickel-chromium alloy, while those in the furnace vestibule and on the loading and unloading tables outside the chamber are of steel. All the rollers are driven together by an electric motor fitted with a variable-speed gear, so that the rate of travel of the work through the furnace can be regulated according to requirements. An interesting feature of the drive is the provision of an automatic, auxiliary electric supply, so that, in the event of failure of the main supply, the rollers are kept rotating on the auxiliary supply, thus clearing the work from the furnace and preventing dis

* These respective furnaces are rated at 415 kw., 515 kw. and 560 kw., having output capacities of 40,000 lb. net per 24 hours for A and B, and 50,000 lb. net for C.

tortion of the rollers such as might occur if these were left stationary at full temperature.

The furnaces are fitted with the Birlec special extra-heavy cast nickel-chromium alloy heating elements, these being mounted both above and below the roller track on which the material is carried through. These elements are, it is safe to say, as nearly as possible indestructible under the most severe conditions of use normally met with, being composed of a number of heavy section cast nickel-chromium alloy ribs welded together to form continuous resisters. It is particularly noteworthy that the special cross-section of these elements makes those in the lower part of the chamber immune from damage by scale, etc. falling from the work. Such foreign matter falls through the elements into a space below, whence it can be removed through clean-out openings provided in the side of the furnace.

The heating elements in each furnace are divided into a number of sections or zones in the length of the chamber to give the necessary graded temperature cycle. In furnaces A and C there is also a rapid-cooling section, and in furnace B a section arranged to give a controlled slow-rate of cooling. Each such section of elements is maintained automatically and independently at the desired temperature by an automatic temperature recording and controlling instrument, the bank of instruments for each furnace being mounted on polished panels fitted with appropriate pilot lights and mounted along the gangway at one end of the installation.

Furnace C, which is designed for consecutive "hardening" and "annealing" has a special cooling section interposed between the first and second heating portions. Thus, the material passes through a complete cycle—heating, soaking, cooling, reheating and final cooling—as it travels through the furnace, and is delivered in the fully-treated state.

The figures given above for output capacity and rating perhaps, give the best possible idea of the magnitude of the installation. It is certainly the largest—if not the only—example of its kind in England, and, in fact, has scarcely been exceeded anywhere in the world, and its smooth, efficient operation and consistent accuracy of treatment are, therefore, gratifying tributes to the experience and skill of its constructors.

Forthcoming Meetings

IRON AND STEEL INSTITUTE.

Oct. 3–4. Joint Annual Autumn Meeting with the Institute of Metals to be held in New York, U.S.A., on the invitation of the American Institute of Mining and Metallurgical Engineers and the American Iron and Steel Institute. The following papers will be presented for discussion: "Recent Developments in the American Iron and Steel Industry," by C. E. Williams; "The Development of Continuous Strip Mills," by D. Eppleheimer, Junior; "Research and Development in the American Non-Ferrous Metal Industry," by Prof. C. H. Mathewson; "Some Characteristics of Copper-Aluminium Alloys Made from Aluminium of Very High Purity," by Marie L. V. Gayler; "Oxidation Resistance in Copper Alloys," by L. E. Price and G. J. Thomas; "The Tarnishing of Silver and Its Prevention," by L. E. Price and G. J. Thomas; and "An X-Ray Study of Dental Amalgams," by A. R. Troiang.
Programmes of a preliminary tour through Canada and a tour through the United States after the Meeting, are available to members from the Organising Officer, Joint Meeting, 4, Grosvenor Gardens, London, S.W. 1.

FOUNDRY CONGRESS

Sept. 8–17. International Foundry Congress, at Warsaw, Poland. A Polish tour has been arranged for those taking part in the Congress, particulars of which are available from Mr. T. Makemson, Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 2.

Aluminium Bromide

By C. C. DOWNIE.

THE successful electro-deposition of aluminium baffled the scientific investigators for many years, and when accompanied by the fact that solid aluminium could be obtained at low cost, the encouragement gained was comparatively meagre. Of recent years, efforts have been made to introduce iron sheets coated with aluminium by a direct rolling process, as the product is rust-proof, and increases the thermal resistance of iron under oxidising conditions. The electrolytic process, however, may yet develop to the extent of competing with the rolled product, and, in the future, might be applied as a means of extracting aluminium from clays, which has long been sought, but at present the cost limits the work to plating for special uses.

Aluminium bromide, with or without the addition of aluminium chloride, is the principal constituent of the electrolyte, whilst the remainder is made up of ethyl bromide, benzene and xylene. Reclamation of the by-products is thus of much importance, as otherwise the costs would be prohibitive. For small-scale work, aluminium bromide is prepared directly from the metallic aluminium turnings dissolved in bromide, after which the other reagents are added. The object in using ethyl bromide is to act as a protective medium, and prevent the plating solution from being affected by the atmosphere. This is a distinct improvement over the earlier use of nitrogen, and other inert gases which had to be passed continuously over the electrolysis bath.

The electrolyte separates into two distinct layers, the upper layer chiefly consisting of part of the ethyl bromide, benzene, and xylene, and containing a small proportion of aluminium salts, whilst below this is the actual plating solution. As moisture must be prevented from interfering with the reactions, it is necessary to fit a cover over the top of the plating bath, which only requires to be removed when changing the electrodes.

If a high current density is applied, the electrolyte tends to heat up, and to meet this contingency external cooling is applied, by immersing the bath in a jacket of continuously-running water. When unduly hot, a low current efficiency is obtained, but where a modified current density will suffice, the cooling arrangements may be dispensed with. The anodes may be of cast aluminium, or aluminium sheet, whilst the same process may be used for depositing aluminium alloys. It is necessary, as with other special electrolytic methods, to use an anode surface which is larger than that of the section to be plated. When first operated, the anodes required to be wire-brushed periodically to remove a skin of oxides which tended to form on the surface. Later examinations revealed that this scum was of organic origin, and although almost transparent, could seriously vitiate the extent of the deposition.

The metal plated is clean, smooth, and strongly adherent, and the finished product can be used for purposes such as where calorised metal is required.

The application of high vacuum technique is increasing, but it is doubtful whether much is known generally on this subject, apart from a limited number of works and in research laboratories. A very interesting publication has been produced and has the virtue that it explains in clear language the theory of vacuum technique, and how vacuum is measured, how systems are built, and includes valuable data with charts, graphs and tables. The selection of pumps is discussed, bearing in mind their relation to associated equipment.

This publication refers to Stokes high vacuum pumps, and a copy will be sent to genuine plant men or laboratory technicians on application to the British representatives for this range of pump, who are W. Edwards and Co., Vaughan Road, Loughboro' Junction, London, S.E. 5. It is a book that should be of value to those interested in processes where vacuum is essential.

Mining Engineers Visit Electrical Works

The importance of good maintenance of electrical equipment was stressed, and attention directed to various instruments and apparatus.

VISITS to works can frequently be as useful to the members of a technical organisation as the presentation of papers, since many aspects in the production of particular equipment, as well as its applications, can be seen at first hand, and discussions which occasionally arise are useful to both the host and guest. The recent visit of members of the Institution of Mining Engineers to the works of the Metropolitan-Vickers Electrical Co. at Trafford Park provided an instance of this kind. The visitors, who included Mr. Carlow, President of the Institution ; the Earl of Crawford and Balcarres, President of the Manchester Geological and Mining Society ; Mr. Laurence Holland, Past President of the Institution ; Mr. Wynne, H.M. Inspector of Mines ; Major Gardiner, Mr. Fletcher, Capt. Walton Brown and others, numbered nearly 150.

One of the parties in the large electrical machine shop of Metropolitan-Vickers Works.

Mr. B. L. Metcalf, who is in charge of the company's mining department, received the visitors at the works, and in a short address said that it was particularly important to have such a distinguished gathering of mining engineers at the present time, when there were murmurings from some of the coal fields of the possibility of legislation being introduced to forbid the use of electricity on the coal face or to restrict it to certain definite areas underground. During the last few years the company had greatly increased the range of its products, which carried Buxton certificates, and it was now an invariable rule never to sell any apparatus as flameproof unless its type had been certified at Buxton.

The importance of good maintenance was stressed by Mr. Metcalf. This, he said, was outside the control of the company, as the responsibility rested with the mining engineer. In this connection, the company offered to co-operate in the training of colliery electricians. It would be preferable for them to spend from three to six months in a manufacturing shop as part of a regular training scheme.

Attention was directed to the Velometer, an instrument of the vane type, which is a velocity meter giving direct indication of air velocities in ft.-min. Another item of interest was the application of the hydraulic coupling to haulages. Mention was made of a coupling for use on a 150 h.p. 585 r.p.m. motor used for driving an endless rope haulage ; it is being installed owing to trouble experienced with an existing mechanical clutch. It is thought there is a field for this coupling on haulages where flameproof resistances are necessary.

Commenting on flameproof resistances, Mr. Metcalf said they took much room, and a comparison between the floor space ccoupied by two typical installations was shown. In one case the equipment consisted of a 50 h.p. slip-ring induction motor-driving an endless rope haulage through triple reduction gear, the motor being controlled by a combined stator and rotor controller with flameproof resistances. The other case consisted of a 50 h.p. squirrel cage motor driving the same endless rope haulage through an hydraulic coupling. The control gear consisted of an oil-immersed star-delta starter. The saving in floor space in favour of the second installation with the coupling was 6.9 sq. ft. or 11.1%. The price of the two installations was nearly the same, but the installation costs of the latter would be less owing to the reduced number of cable connections. The hydraulic coupling is self-contained, a reservoir casing being carried by the driving end of the coupling. In this reservoir is an eccentrically mounted scoop-tube, and movement of a lever external to the casing alters the distance between the end of the scoop-tube and the reservoir casing, thus altering the thickness of the annular ring of oil in the reservoir. The scoop-tube transfers oil from the reservoir into the working circuit of the coupling and the position of the scoop-tube relative to the periphery of the reservoir determines the amount of oil in the working circuit and therefore the slip of the coupling.

Metrovic "Slow-banker" with type C Lilly Controller mounted on top of its casing.

Reference was also made to the problem connected with the protection of electric winders, particularly since the introduction of the new regulations designed to prevent bumping. Demonstrations were given of duplex Lilly controllers and Lilly controllers operating with slow

bankers, also of the cage-landing speed recorder and hand-operated transmitter.

The visitors were divided into parties and were conducted on a tour of part of the works, including the research department and the main assembly shops to see turbines and large alternators and motors. The foundry, tank shop, transformer department, and insulation department were also included in the tour. After lunch the visitors received a welcome by Mr. Peck, director and chief engineer of the company, who gave some interesting figures relating to the enormous growth of the company in recent years. Mr. Carlow replied on behalf of the Institution.

Small Centrifugal Oil Purifiers

MUCH interest attaches to a new "Hopkinsons" small "No. O" centrifugal oil purifier, available either in the stationary or portable form, with a duty of 20 to 30 gallons of oil per hour. This has been designed to meet the demand for a unit that is smaller and cheaper than the range of centrifugal purifiers hitherto made by Hopkinsons Limited. The machine essentially consists of a bowl containing a pack of thin metal separation cones or plates, assembled one above the other on a central tube with a conical base. The bowl is carried on a vertical shaft running in ball bearings, and the drive is by worm gearing from a ball-bearing horizontal shaft, so that the bowl is driven at a speed of 11,000 revs. per minute.

The standard driving arrangement is by direct-coupled fractional h.p. motor, flange-mounted on the body of the machine, operating the horizontal worm-wheel shaft through a dog clutch. The horizontal shaft complete, with bearings and one member of the clutch, can be withdrawn as a single unit through a side door in the body. Alternatively, the machine is supplied with fast and loose pulleys on the horizontal shaft for belt-drive.

The vertical spindle has a special type ball bearing at the lower end in a housing, which allows of vertical sliding movement, while the underside of the housing rests on a spring which damps out vibration and ensures smooth running. At the upper end of the vertical spindle is a second ball bearing, the housing of which has horizontal springs for "centering," whilst allowing any slight lateral movement when the bowl becomes loaded with impurities.

Also the upper part of the worm spindle, which carries the bowl, is chromium plated for protection against both wear and corrosion. Dirty oil enters at the feed cup, passing down a central inlet pipe, and flowing, while subjected to a powerful centrifugal force, up between the conical inserts. The heavier water and sludge is forced to the outside and discharges by an outlet at the top of the stationary outer casing, while the clean oil passes to the centre and flows out by another opening higher up, by way of a concentric space round the outside of the inlet pipe.

In the new "No. O" design the bowl is machined from best-quality steel forgings, all parts liable to be in contact with corrosive liquids being protected by heavy chromium on nickel coating, with gunmetal distributor and top-plate. Surmounting the bowl are three nickel-plated sheet-metal covers or traps, the upper one being for overflow, in case the oil is fed too rapidly or the bowl choked with solid matter. The other two metal covers are for collection of the separated liquids, that is purified oil and water along with other impurities.

As it is not always possible to arrange for gravity feed, or to return the purified oil by gravity, pumps can be mounted on the machine body or frame, driven from the worm-wheel shaft, for either or both of these duties. In general, the new machine is an extremely compact unit, and will be useful in many establishments where requirements do not justify the investment in the larger sizes hitherto produced.

Burdon Furnaces Ltd., designers and builders of all types of industrial furnaces, are now occupying new offices and works on the Scottish Industrial Estate, Hillington, Glasgow, S.W. 2.

Technical Information on Tin

Structure of Tin and Zinc Coatings

ELECTRODEPOSITION and hot-dipping are largely used methods of applying protective coatings to steel and other metals. The choice of the method to be used is influenced not only by manufacturing considerations, but also by the use to which the coated article is to be put, for the two types of coating, electrodeposited and hot-dipped, vary very much in their behaviour when subjected to deformation, corrosion and other causes of wear. There has been a good deal of work done to ascertain the fundamental differences between the two types of coatings and this work, and some original contributions to it, are reviewed by D. J. Macnaughtan, in a recent publication.

The microscope, X-ray and electron-diffusion have been instrumental in elucidating what is at present known regarding the structure of coatings. It is only in recent years that the technique for examining the cross-section of a coating of metal has been developed. It is also pointed out that hot-dipped metals may be regarded as extremely thin chill-castings adhering to the basis metal, and a view of the micro-structure of the surface is not necessarily any indication of the underlying structure. Examination of the cross-section of thin layers shows the crystal structures to be very different according to the conditions of their formation. The reasons for the differences which occur in the case of tin and of zinc are discussed. When subjected to deformation zinc coatings break sharply while tin stretch in a ductile manner as shown in a number of photomicrographs. The effect of co-deposited matter in producing boundary embrittlement is also discussed.

Tin Estimation with Dithiol

"Dithiol" is now available commercially as the toluene —3 : 4—dithiol and Clark's method for the colorimetric determination of tin has conveniently been modified to enable this reagent to be used instead of the substituted benzene dithiols originally used. Full details of the new procedure are given by R. E. D. Clark, in a recent publication.

Boundary between Tin Crystals

The effect of the boundary between the crystallites in a metal specimen on the mechanical behaviour is of fundamental importance for the understanding of the strength of polycrystalline metals. In a recent paper read by Dr. Bruce Chalmers before the Royal Society, on "The Influence of the Difference of Orientation of Two Crystals on the Mechanical Effect of their Boundary," he considers a simple case in which the effect of a single boundary can be measured. The specimens tested consist of two crystals of tin with a longitudinal boundary prepared so that the orientation of the lattices of the two crystals with respect to the direction of the stress is the same in all cases, while the angle between the two lattices varies from specimen to specimen. It is concluded that the boundary has no inherent strength, and that the results are best explained as the effect of a transitional lattice. The evidence is against the existence of an "amorphous layer," or "intercrystalline cement." This paper has now been published.

These are published by the International Tin Research and Development Council, from whom copies may be obtained free of charge at Manfield House, 378, Strand, London, W.C. 2.

In Ontario, Canada Radium Mines, Ltd., has been conducting underground exploration of pegmatite bodies for some years past at Cheddar, in Cardiff township, Haliburton County. The pegmatites are stated by the company to carry radio-active and other minerals. Work was suspended during 1937.

Reviews of Current Literature

Foundry Sands

THIS book, which is No. 10 of Griffin's series of " Industrial Textbooks," edited by Dr. Percy Longmuir, deals with the characteristics and testing of various sands and special reference is made to steel foundry practice. The origin of sands and clays, the weathering of igneous rocks and the transport and deposition of particles, is discussed, and it is shown that it is possible to choose a sand which occurs naturally in the form of quartz grains each surrounded by a film of clay, or to choose a sand which occurs in the form of silica grains alone, and to select a clay similarly occurring alone, possibly from a different locality, and mill them together.

Such factors as plasticity, green and dry strength, permeability, refractory properties, uniformity, and grain size and shape are reviewed in a clear style. An interesting section regarding testing for permeability is included, and of which an example may be given. " This permeability number may be defined as the number of cubic centimetres of air which will pass through a specimenn one centimetre long and of one square centimetre cross-section in one minute, the pressure forcing the air through the specimen being that given by one gramme weight per square centimetre. To obtain this number from tests in any particular type of testing apparatus, if V is the volume of air in cubic centimetres passing through a specimen of length, L, centimetres and cross-sectional are A, square centimetres in a time T minutes, the pressure being P grammes weight per square centrmetre, then the permeability number N is given by $N = \frac{V\ L\ ,,}{A\ T\ P}$.

Following the characteristics of sand grains and clays are the chapters on sand testing, and the applications of sand testing. The latter includes the testing of sand beds by the supplier, examination by the user of raw moulding, silica and facing sands, and the control of foundry batches.

Three very useful chapters are those on sands and clays for green-sand moulding ; sands for dry-sand moulding ; and core sands and mixtures. Mention is made of silicon ester which has recently been used for core binding, though on a small scale. This organic compound is a colourless liquid giving very little green strength. On heating, alcohol is driven off, leaving silica behind, and this, being distributed as a thin solid coating between the grains, supplies dry strength which persists at high temperatures. It is a convenient binder for small, simple cores, but expensive to use. The final chapter is devoted to the preparation and handling of sand, and includes milling, reclamation and desilting.

Foundry technologists should welcome this book, which gives facts and figures for the adoption of system in the control of sands and bonding materials.

By T. R. Walker, M.A., F.I.C., F.G.S. ; published by Charles Griffin and Co., Ltd., 42, Drury Lane, London, W.C. 2. ; price 4s. net.

Swedenborg's Treatise on Copper

THE British Non-Ferrous Metals Research Association, in co-operation with the Swedenborg Society, has performed a very useful service to the scientific public and all interested in copper and its alloys, by publishing a translation of this famous work, more generally known under the abbreviated title " De Cupro." For economical reasons the translation is in mimeographed form and bound in three parts. It is regrettable that numerous illustrations in the Latin original have not been included, but the reproduction of these would have added considerably to the cost, and those who really need the illustrations can obtain copies by the photostat method.

The learned and many-sided Swedish scientist, philosopher and mystic, Emanuel Swedenborg, was born at Stockholm, in 1688. As early as 1721 he was seeking a scientific explanation of the universe when he published his *Prodromus Principiarum Rerum Naturalium* and had already written his *Principia* in its first form. In 1734 appeared in three volumes *Opera Philosophica et Mineralia*, the first volume (his *Principia*) containing his view of the first principles of the universe, a curious mechanical and geometrical theory of the origin of things ; the second volume deals with iron and steel ; and the third volume, the translation of which is here reviewed, is concerned with copper, its smelting, conversion and assaying, and containing the results of many experiments.

Swedenborg's writings were not properly collected until towards the end of the 19th century ; it was then seen that in almost every department of scientific activity he was ahead of his time. His work on palæontology shows him the predecessor of all the Scandinavian geologists. He was also a great physicist and had arrived at the nebular hypotheses theory of the formation of the planets and the sun long before Kant and Laplace ; he wrote a lucid account of the phenomenon of phosphorescence and adduced a molecular magnetic theory which anticipated some of the chief features of modern hypotheses. Dumas, the French chemist, credits him with the first attempt to establish a system of crystallography.

The first two volumes of his Latin treatise, *Opera Philosophica et Mineralia*, have been translated, but no translation of the third volume has hitherto been generally available. This latter volume consists of three parts, the first of which deals with the methods of smelting and refining copper in use at the time in Sweden, England, Germany, Russia and elsewhere ; with the separation of silver from copper ; with brass and its preparation as practised in Sweden, England, Germany, etc. ; and with the casting of bell-metal, statues, cannon, printing type, and shot. The second part describes methods of assaying copper ore, and the assaying of the silver content. The third and last part deals with various chemical experiments on copper and brass, the preparation of compounds of copper, the density of copper and related matters. The translation of this volume was prepared by the late Mr. A. H. Searle in 1901, but for various reasons it was not published, the manuscript being deposited with the Swedenborg Society. The British Non-Ferrous Metals Research Association, by kind permission of the Swedenborg Society, undertook to issue this translation in a form available to the public, hence this present edition.

The language of the author is noteworthy. In his preface he says : " The subterranean kingdom is so rich that it not only produces minerals, metals, stones and earths, but also . . . with the assistance of the elementary world, it nourishes as many species of living beings. It is so luxuriant that it labours under its very abundance. . . . What can be more wonderful than that, in the coldest climates and zones, in the northern regions, lying almost directly under the Great Bear, ores of such rich metal should originate and be produced, that the regions lying directly under the influence of Sirius and Phœbus, and burning hot with our south wind, scarcely abound in richer or more precious metals. How great an abundance of copper has not been afforded to its miners by that great mine at Fahlun, which is still unexhausted after having been worked continuously for a period of a thousand years. . . . Further north, as in Lapland, . . . under the Plough itself, there are found here and there very abundant and rich ores, as well of copper as of iron, for example, vitreous ores of silver, of copper, and other kinds ; and this frequently under the eternally snow-covered earth, . . . and in that icy bosom is cherished the embryo of that metal which seems to love warmer wombs, and to wish, as it were, to be drawn out, brought forth, and nourished, by the rays of a nearer sun."

There is a wealth of detail in this work which is very unusual in technical books, the descriptions of various works and methods of fusing and refining copper at a very

wide range of places and countries are particularly interesting and informative as a result of the careful attention given to details by the author. The translation of this part of the work occupies 237 pages. The description of methods adopted for the separation of silver from copper, which occupies about 70 pages, is presented in a similar manner.

The description of brass and its preparation is very interesting; here again the author deals with the preparation of brass in many countries, and compares the methods then adopted at various works. A knowledge of brass and its preparation is not possible, it is stated, unless the nature and quality of calamine stone, which is one of the constituents of brass, is first explained. Brief particulars of this stone or of cadmia are given to assist in the knowledge of brass. It had been noticed that English stone of this kind was very heavy, by reason of it being more impregnated with lead. It is noteworthy that, in England, what is termed Goslar calamine stone was obtained by the direct smelting of lead ores; chiefly it sticks to the breast wall of the kiln or furnace, and when the process of fusion had been repeated many times it was seen to have condensed on the walls to the thickness of a handbreadth. It is interesting to note that the calamine stone was exposed to the sun, the longer it was so exposed the better it was said to be, and a time of one, two or three years is mentioned.

The translation of the second and third parts of the original book are contained in the third section. The second part deals with the various methods of assaying copper ore and stone, a detailed description of different kinds of copper ore and of pyrites is given; the type furnaces, fluxes, and the assaying methods adopted; the assaying of copper for silver is included, as also is the assaying of impure metal, arsenical metal, antimonial metal, bell metal, etc., for silver, and the assaying of silver lead for silver. The third part is confined to a description of various chemical preparations and experiments made with copper and brass.

The present edition includes a foreword giving the history of the manuscript translation, and a biographical note on the translator, Arthur Hodson Searle, who was born in 1839 and died in 1914. At the age of about four he suffered an illness which deprived him completely of his hearing, and consequently for a time of speech. He was taught the finger alphabet and lip-reading, and thus learned to converse, although in a somewhat muffled voice. In spite of these physical disabilities he became an excellent Hebrew and Latin scholar. He was not a metallurgist, being in fact occupied as an artist in reproducing for the engraver plates of conchological specimens. All in all, his preparation of this translation is a remarkable achievement, and no reader of it can fail to be impressed by its quality.

The British Non-Ferrous Metals Research Association is to be congratulated on the publication of this edition, and the work of Mr. B. Fullman especially is commendable for undertaking such a formidable task. Published in three sections totalling 536 13 in. by 8 in. pages, this mimeographed edition is released for sale to members of the Association at the reduced price of 15s. (plus postage), and to the general public at 25s. per set (plus postage, 1s. in Great Britain, 3s. abroad). British Non-Ferrous Metals Research Association, Requart Buildings, Euston Street, London, N.W. 1.

Aluminium

FROM America comes a useful addition to the present literature on light alloys. The rapid development of these metals has resulted in a large, important industry possessing a very small amount of collected technical literature. As time goes on, this state of affairs will doubtless be changed.

In his preface the author states that he has written primarily to fulfil the needs of the student to whom essentials are essential and excessive detail unnecessary. The volume is divided into two parts: the first dealing with the history, metallurgy and fabrication of aluminium and its alloys, while the second part describes the manufacture of some simple metal objects in the home or school workshop.

The 25 projects which are illustrated and described in this second part are chosen for their inclusion of the more common processes employed in fabricating aluminium and its alloys, and are given in a logical sequence, leading from basic metalworking operations such as bending and sawing to more difficult operations. Once these operations have been explained in a project, they are not repeated in succeeding projects. The author has taken much trouble to make out inventories for the materials and specifications needed for each project. This will be particularly useful in handicraft centres, where the many advantages of aluminium have not been exploited.

Mr. Hobbs also deserves congratulation on the first part of the book. The language used is simple and clear, and anybody can understand the processes which are included in the production of various articles from the light alloys. The excellent illustrations really illustrate the subject matter, and are a feature which could be noted by British publishers. In some places the text could be clarified by the inclusion of a few more line diagrams, but this comment in no way detracts from the excellence of the book.

A very good account is given of methods of surface finish. It is to be regretted that the author has given all the temperatures in Fahrenheit units for American readers, and it is to be hoped that in future editions of this book the Centrigrade equivalents will also be given for English readers who are more familiar with these units. It will be appreciated that part two of the book is of greater interest to the metal worker, especially the handicraft teacher, as artistic effects are described, and full directions and working drawings given.

Excellently bound, the volume presents an attractive appearance, and this is maintained by clear printing on good art paper. This is a publication which should find a place in every library attached to works or colleges where light metals are used or studied.

By Douglas B. Hobbs; published by the Bruce Publishing Co., Milwankee, U.S.A.

A Manual of Foundry Practice

WHEN the first edition of this book appeared some three years ago, METALLURGIA stated that this collaboration of a foundry superintendent and a metallurgist covered the various sections of the principle and practice of the foundry admirably. In this second and revised edition, even more ground is covered, and the treatment of non-ferrous alloys has been included. The amount of additional matter makes this publication of even greater value.

This comprehensive volume gives an account of modern British methods of production and embodies all those details which are essential to success in practice; details that are not covered in some textbooks largely owing to the transformation in foundry practice that has taken place during recent years.

The scope of the work is indicated by the fact that it covers the principles of moulding and core making, of moulding tackle and technique, plate and machine moulding, moulding is then considered together with running in relation to design—this forming a most valuable chapter —and loam moulding.

The metallurgy of cast iron and melting of cast iron are dealt with separately, and are followed by descriptions of special methods of production such as chill and malleable cast iron, and the subject of non-ferrous founding has been treated at greater length, By J. Laing and R. T. Rolfe, this book is published at 18s. net, by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C. 2,

Adherent Nickel Plating

By E. E. Halls

Close concentration on the efficiency of preparatory operations is stressed with a view to obtaining the proper adherence of the coatings. The need for a proper appreciation of what each stage in the operations can achieve is emphasised to ensure that each treatment will deal with the contamination it is designed to remove.

THE adherence of nickel-plate coatings is dependent upon several factors which may be briefly summarised as cleaning, surface preparation, and nickel-plating proper. Each of these is important in itself, and unless proper attention is given to all of them, satisfactory results cannot be secured. A visual examination for the effectiveness of nickel deposition as work passes through the vats is not nowadays considered an adequate evaluation of the quality of the nickel coating. Even less satisfactory is a casual visual examination of work in process sufficient for the determination of cleaning efficiency. In point of fact, design and control of the preliminary operations are probably more neglected than they are in the plating operation proper.

Cleaning

The usual practice of cleaning by thorough degreasing, pickling or acid dipping to remove surface tarnish, oxide or scale, and quickly following by nickel plating with sometimes a flash copper plate prior to the latter, can be quite satisfactory providing each operation is carried out with meticulous care. In dealing with a variety of work, however, it is not always possible to guarantee that any one of these operations is entirely satisfactory, unless the operation has been particularly designed to take care of the worst case involved. Again, attention has to be given to the particular practice adopted according to the metal to be plated, and the condition in which it is received. For instance, brass can, with advantage, be given entirely different treatment to iron or steel, while again, whether the material is polished or in the "as rolled" condition, or whether it constitutes simple sheet-metal work, pressings, castings, or heat-treated articles, has some bearing upon the best procedure. The question of these surface conditions is rather complex, and one universal treatment will not cater for them all. For example, cold-rolled bright mild steel bar or section should be, and usually is, only contaminated by a light protective coating of grease or oil, the metal surface itself being otherwise clean, bright and metallic. Some mills, however, who carry out annealing operations in coffins immediately prior to the final draw, consider the finish of the metal at this stage good enough to pass on to the final operations without a light pickle. The consequence is that blackish solid matter, which may be oxide or carbonaceous contamination, becomes drawn into the surface, giving a very poor appearance after oiling, and a surface which is exceedingly difficult to render chemically clean. To add to the difficulties, any machine shop operations in the nature of forming or bending further promote the enbedding of this extraneous solid matter into the surface of the metal.

Other instances comprise heat-treated parts, such as oil-hardened and tempered screws, spindles, links, etc., which, according to fluctuations in process conditions, may have oil burnt on them to give tenacious carbon deposits or may acquire refractory oxide films ; drawn brass or steel objects which may have left upon them films or patches of difficultly soluble soap greases, and sand castings having sand inclusions. Consequently, the bulk of the product handled through a plating shop of any size will exhibit a varied and miscellaneous surface condition, and any pre-cleaning processes instituted must be such that cater for completely dealing with these diversities. In general, these pre-cleanings must be considered distinctly from any preparatory etchings adopted to improve nickel adhesion. The simplest appropriate treatment should be chosen from degreasing, pickling, acid dipping, sand or shot blasting, or brush scouring, according to circumstances.

The British Non-Ferrous Metals Research Association has carried out extensive researches on the question of adhesion of electro-deposited nickel on brass, and the results of their work were published under Research No. 36, in May, 1932. This recommended an electrolytic etch which could use either a 5% solution of potassium cyanide or a solution of ammonium citrate, prepared from 50 grms. of citric acid dissolved in water, neutralised with ammonia, and then treated with a further 20 grms. of citric acid, then making the solution up to 1 litre. Both these solutions are employed anodically, preferably at a low current density of 5 to 10 amperes per sq. ft. As an alternative, a straightforward aqueous nitric acid etch, using solutions up to 50% by volume is satisfactory in providing adhesion, although of course it exerts a more dissolving effect upon the brass. In commercial practice it is more general to give the brass a dip first in a solution of three parts of nitric acid and one part of sulphuric acid, and then, after water rinsing, to follow with a dip in a solution of one part of nitric acid and three parts of sulphuric acid. The work is then quickly water washed, given a rinse in a 5% sodium cyanide solution, water washed again, and passed to the plating bath. The presence of sulphuric acid in the dip suppresses the attack by the nitric constituent considerably, without detriment to its etching powers. On brass there is very little difficulty in this etching treatment, and providing the other operations are sound, little trouble should be expected.

Plating Steel Components

On miscellaneous steel components, however, the problem is often found to be a little more complicated. The soundest general practice is to use an anodic sulphuric acid etching treatment, and the procedure in this case would be as follows :—First the work would be cleaned to remove the bulk of grease and swarf, using trichlorethylene vapour, or a liquor-vapour plant, or a caustic alkali solution. It would then be given an electrolytic clean to remove final traces of grease, and the solution employed for this can be one of several. A satisfactory one comprises 2 oz. of soda ash and 2 oz. of sodium metasilicate per gallon of water. Another one uses a mixture of caustic soda and tri-sodium phosphate, approximately 2 oz. of each per gallon of water. These solutions are operated at about 170° F. with a voltage of 6 to 8 volts. The work is made cathode and iron anodes are employed. The minimum of time is allowed in this solution, and water swilling quickly follows. The wet work is then transferred to the anodic etching solution, which comprises sulphuric acid of specific gravity between 1·65 and 1·70. This can be operated cold, and as the solution gets hot in use a cooling coil is usually included, but a temperature of 140° F. is often employed. The work is made the anode, lead cathodes being employed, and conditions are controlled by voltage, this being maintained between 6 and 8 volts. The time period is controlled to the minimum, ranging from a few

seconds to a minute. Work is thoroughly swilled, and then passed rapidly to the nickel solution.

This procedure works entirely satisfactorily, providing the nickel-plating solution is controlled with respect to nickel content, chlorine content, and pH value. The first two items can range fairly widely, but the latter is preferably controlled to plus or minus 0·1 in the range between 5·0 to 6·2, according to conditions.

In many practices a copper under-coat is employed, but the main purpose of this is really to even up any roughness in base material. Consequently it should be a fairly heavy coating and applied first from a cyanide bath and then a sulphate solution. It does not materially improve adhesion, and cannot be regarded as contributing to pre-cleaning processes which must therefore be carried out at maximum efficiency. Flash copper coatings thus have very little real practical value.

Conveyerising Practice

On conveyerised plating lines, where brass and steel have to pass through the same system, it is obvious that the main degreasing and pickling must be performed prior to the common plating line. Steel work, for instance, if requiring a pickle would have to have a hydrochloric or a sulphuric acid dip, whereas brass is given a more vigorous nitro-sulphuric acid treatment or a sulphuric chromic immersion. However, as far as the common line is concerned, satisfactory results are obtained with a cathodic electrolytic clean in a mild alkaline degreaser, followed by the usual water washing, and then a cathodic clean in an alkaline solution containing cyanide, again followed by water washing, this being succeeded by a dip in dilute sulphuric acid, water swilling, and nickel plating. It is important that in transferring the work from one tank 5o the next that drying off should not occur. There are several objections to the latter. Firstly, if work dries, it has got to be uniformly re-wetted in the next tank and under such conditions the provision of a uniform surface state is not easily obtained in this tank. Secondly, chemicals drying on are not so easily removed in the next rinse. Thirdly, and of highest importance, drying off promotes surface oxidation, either rust or tarnish, which, however slight, is detrimental to the final nickel adhesion. The first clean should be a sodium metasilicate base solution, and it can comprise 2 oz. of sodium metasilicate and 2 oz. of soda ash per gallon. 6 to 8 volts is a suitable pressure, and a temperature between 140° and 170° F. is sufficient. Cold water washing can be employed. The cathodic cyanide clean can be a dilute solution of approximately 4 oz. per gallon of a mixture of 90% common sodium phosphate and 10% of sodium cyanide. This is employed cold at a voltage of 6 to 8 volts, but care must be taken to ensure that the cyanide concentration is maintained. All the subsequent water washes can be cold, and likewise the sulphuric acid treatment for which a 10% solution by volume is the maximum concentration required.

With nickel-plating solutions in the highly developed condition they are to-day, made up from pure chemicals and with temperature and pH value controlled, practically all the adhesion troubles are associated with the preliminary treatments, and the foregoing cover a satisfactory range for all purposes. The greatest troubles encountered are either due to haphazard cleaning, or more often to a lack of appreciation of the fact that work tarnishes or oxidises as it passes from one step to the next in a series of operations if the passage is at all unduly delayed. A recent example was a formed iron component finished copper nickel, the copper coat being 0·1 to 0·2 mils. average thickness, and the nickel 0·5 to 1·0. The nickel peeled badly, and investigation showed this to be entirely due to an unduly long time-lag between coppering and nickeling, during which slight tarnishing occurred. Correction of this indiscretion eliminated the fault.

The above is not intended as a discussion of nickel-plating methods, but to stress primarily the need for a close concentration upon the efficiency of preparatory operations. Whatever series of operations is adopted, it is essential to appreciate what each stage can achieve, and its limitations, and to ensure that each individual treatment will deal adequately with the contamination it is designed to remove.

Cold-Rolling Tests on Nickel, Copper and Brass-plated Steel

THE object of investigations on the above subject, by Pomp and Weddige,* was to find out how plated steel behaves if cold rolled, especially how the properties of steel important for the rolling process may be influenced by the plating part.

Plating means, as is well known, the inseparable connection of a base-metal with a comparatively thin cover of another metal by using pressure or high temperature, or both. The base-metal is mostly soft steel ; the cover may consist of stainless steel, nickel, copper, brass, aluminium, etc. Plated steel is used in order to combine the favourable stress properties of steel with the good corrosion resistance of the cover-metal, or in order to spare the expensive non-ferrous metals and high-alloy steels.

The original plating method, patented in 1878, consists of covering a steel slab by a non-ferrous plate, heating both while air is excluded, and rolling both together in one heat. The steel slab, as well as the plating metal, must have a completely faultless and clean surface. The original thickness of the slab is, say, eight to ten times the thickness of the final plate or strip in order to obtain good working through the material and complete welding between base-metal and cover-metal. The strips or plates, so plated, can be treated by cold rolling without endangering the plating.

For the investigations test-pieces were used consisting of the base-metal and the cover-metal alone, as well as plated on one or both sides with either nickel, copper or brass, the thickness of the plating being nickel 3%, copper 5%, and brass either 5% or 7·5% of the total thickness, which was throughout two millimetres.

The experiments were carried out at a special rolling plant with rolls of chrome steel. Two longitudinal lines were etched into the surface of one of these rolls over a distance of 180°. They made marks on the material rolled, well visible after the rolling, and thus it was possible to determine the forward slip of the material against the rolls. The rolling pressure was measured by a recording hydraulic pressure meter. The test-pieces were rolled in one pass to a thickness of 1·9, 1·8, 1·6, 1·4, 1·2 and 1·0 mm., respectively, corresponding to a reduction of 5, 10, 20, 30, 40 and 50%, lubricating the material during the rolling process with rape oil.

The results of the experiments are shown in tables, which give the dimensions of the different test-pieces before and after the rolling, decrease of thickness and increase of width in per cent., the pressed length and pressed area, the roll pressure and the tensile strength, and the elongation of the material after rolling. The deformation resistance and the forward slip of the base-material were substantially changed by the plating, one-sided plating increasing and double-sided plating decreasing the deformation resistance. The forward slip was greater with all plated steels than at the base-steel, with the exception of the double-sided nickel-plated one, and the one-sided plated steels gave the greatest forward slips. The increase of width was not much influenced by the plating. The tensile strengths of the plated steels were somewhat smaller than the base material, but the elongations were unchanged.

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* *Mitteilungen aus dem Kaiser-Wilhelm-Institut fur Eisenforschung in Dusseldorf*, vol. XX. No 4. By Anton Pomp and Georg Weddige. Price RM. 2,35

Recent Developments in Materials, Tools and Equipment

Electric Furnaces and New Methods of Case-Hardening

AS an alternative to the normal pack-hardening method of carburising, an interesting type of furnace has of late years been developed in which the case is obtained by the circulation of hydrocarbon gases through the work at the usual operating temperatures. Certain natural gas has been shown to be capable of producing a high quality case, but in general the new furnaces operate upon a specially blended oil known as Carbonol, which, when vaporised, produces a gas that is particularly suitable for carburising. The principle is not new, as it has been known since the middle of the 19th century, but its commercial application is only recent.

The method of operation can be followed by reference to the sectional view of a furnace made by the Heviduty Electric Co., of Milwaukee, which is reproduced in Fig. 1. It will be seen that in general construction this resembles a normal type of pit furnace, the heating elements being of heavy section connected in separate circuits, so as to give two or more separately controlled heating zones according to the depth of the chamber. These zones are independently energised from magnetic switches actuated by automatic control pyrometers. Into this heating chamber is inserted a cast nickel-chrome retort supported in the bottom of the chamber in the manner shown, and closed gas-tight by means of a bolted type of cover with asbestos gasket. This cover carries a motor-driven fan. The latter is of the centrifugal type mounted below the cover and extending into the retort when this is closed, while the motor on a long extended shaft is carried well above the cover.

The work is loaded into a perforated basket, which is placed in the retort, the cover placed in position and bolted tight, after which the charge is brought up to the required carburising temperature. Oil is then admitted to the closed retort from a suitable container through piping provided with a sight-feed indicator. When the supply is turned on, the Carbonol oil drips into the fan discharge, where it vaporises and is forced against the hot sides of the retort. The violent impingement of the partially cracked gas on the work in the basket causes a further cracking to take place which improves the activity of the carburising gas. Excess and partially exhausted gas is discharged through the outlet pipe, where it is usually burnt.

After carburising for the length of time necessary for the desired depth of case, the oil drip is shut off, and the furnace held at temperature for an hour or two to allow for diffusion of the case. The cooling of the charge can be effected by various methods, depending upon the results desired; for instance, the entire retort assembly with sealed cover and charge may be lifted out of the furnace to permit the charge to pass through a controlled cooling cycle, cooled in air or in a cooling chamber to prevent scale, or alternatively the basket and charge may be removed from the retort and transferred to a cooling chamber. Direct quenching from the carburising or other suitable temperature is also practised in many cases.

For ordinary case depths, penetration in the case of S.A.E. 1,020 steel takes place at a rate of approximately 0·012 in. to 0·015 in. per hour at 940° C. A $\frac{1}{16}$ in. case requires from 4 to 5 hours, depending somewhat upon whether the stock is cold-worked, forged, or hot-rolled, and the surface condition. Pearlitic manganese steels, designed particularly for carburising, show a better penetration varying from 0·015 in. to 0·018 in. per hour. The

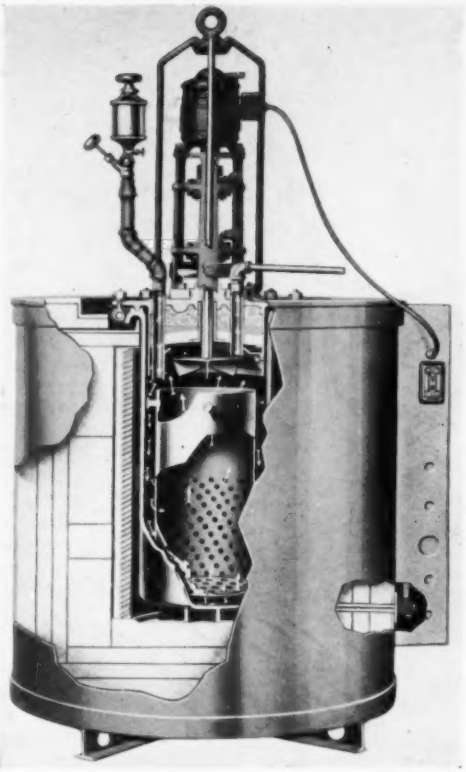


Fig. 1—Electric furnace for case-hardening, in which a blended oil is used for circulating hydrocarbon gases.

use of this furnace is claimed to permit of very close control, not only of the depth of case, but also carbon content and graduation. In loading, no special attention requires to be paid to placing the work in the basket, and in normal circumstances it is not necessary to separate the parts. Microscopic examination has shown no effect on the case when two round rod samples were tightly wired together during carburising. There is, of course, the risk that if too much weight is placed on the lower part of the charge distortion under heat might take place, but this can be overcome by using sectional baskets to distribute the weight and separate the bulk of the charge.

The type of furnace described is now made in six standard sizes, the smallest with a loading space 9¼ in. diameter by 19½ in. deep, rated at 16 kw., and the largest 24 in. diameter by 48 in. deep, rated at 105 kw. The following is a record of five charges put through the smallest furnace under varying conditions, which will give an idea of the results obtained by the new method :—

RECORD OF FIVE CHARGES UNDER VARIOUS WORKING CONDITIONS.

No. of charge	1	2	3	4	5
Work	Bolts.	Pins and Bolts.	Pins and Bolts.	Forged Tram Shoes.	Forged Tram Shoes.
Weight of charge, lb. ..	190	188	229	116	116
Furnace temperature on charging, °C.	935	935	935	Cold	935
Cover temperature on charging, °C.	925	925	925	Cold	925
Retort temperature on charging, °C.	925	925	925	Cold	925
Basket temperature on charging, °C.	Cold	Cold	Cold	Cold	Cold
Load temperature on charging, °C.	Cold	Cold	Cold	Cold	Cold
Kwh. for heating up ...	31	45	43	69	20
Kwh. for carburising ...	20	24	26	34	35
Total kwh. used	51	69	69	103	55
Radiation per hour, kw.	6·7	8	8·7	8·5	7·8
Time heating up, h.m.. .	2·10	3·10	3·20	3·45	1·25
Time carburising, h. ...	3	3	3	4	4½
Carbonal per heat, pts.. .	1	1	1	1½	1½
Depth of case, inches ..	L45	0·045	0·045	0·060	0·065

Fig. 2.—A gear after carburisation in the furnace, showing the case.

In considering the figures given in the foregoing table, the following facts require to be borne in mind: In charge No. 1, the radiation loss during the heat is lower than any of the others, which is due to the fact that when this charge was put through the furnace had been in use for a long period and was thoroughly saturated. This also accounts for the rapid heating-up time and the low power consumption. The production figures on this heat therefore show what can be done if the furnace is used in continuous production. In charge No. 2 the weight is almost identical with the first, but in this case the furnace was merely brought up to heat a short time before it was loaded, and the production figures in this case therefore show the results to be expected from intermittent working. The third charge was similar to the first two, but the basket was more heavily loaded, the weight being practically the maximum for this particular size of furnace except in rare cases. The furnace was not completely saturated when this charge was put through. The fourth charge was loaded into a cold furnace after a week-end shut-down, and was brought up to heat with the charge. The fifth charge was exactly the same as the preceding one, but the furnace was up to carburising temperature when loaded. A comparison of the last two heats will show the advantage of using the furnace for continuous operation.

As far as the cost of renewals is concerned, the standard alloy retorts usually supplied have a guaranteed life of 3,500 hours in the furnace; the alloy baskets have a life of 1,500 hours' minimum. The consumption of Carbonol for normal calculation purposes is taken as 6 quarts per ton of steel carburised, and the price is the equivalent of 1s. per quart. It might be here mentioned that there is also available a modified blend of oil for low-temperature carburising at about 735° C. upwards, which, however, is only suitable for very thin cases.

Apart from carburising, this type of furnace can also be used for nitriding, with only a few very minor changes of piping on the cover. Bright annealing of non-ferrous metals under protective gas can also be undertake successfully.

Dust Removal from Grinding Machine

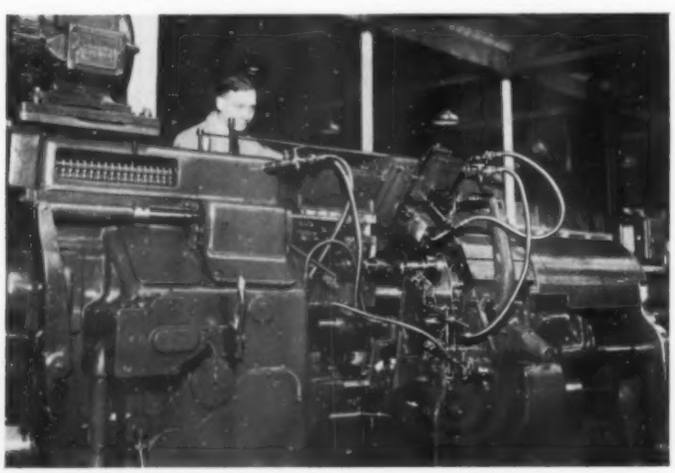
IT is well known that when operating grinding machines in the engineering and other industries great care must be taken to prevent the dangerous metal dust from being discharged to the atmosphere. In this connection the use of a complicated system of trunking, connecting to every machine, and to a large central fan, is apt to be a costly method to instal, and requires also excessive power, although much depends upon the industrial conditions. Considerable interest attaches therefore to the latest design of the "C G" type self-contained dust collectors of the Visco Engineering Co., Ltd., who specialise in dust removal, more especially by the centrifugal, oil-film and bag-filtration methods.

These collectors are intended for average, medium and heavy duty, and the arrangement, which is very neat and compact, consists essentially of a small high-speed exhauster or suction fan and direct-coupled electric motor, attached to a rectangular metal casing, which contains in the bottom portion a primary centrifugal separator, and in the top portion a special oil-film filter cell or secondary separator. The entire unit is fixed overhead or on the floor in any convenient position adjacent to the grinder, the fan inlet being connected by trunking to the collector hood, so that it discharges all the dust-laden air to the primary separator and the oil-film filter. From the latter the cleaned air can in most instances be returned to the workshop.

Whilst passing through the primary separator almost the whole of the dust is separated by centrifugal action, and the air then enters the oil-film filter cell, which consists of a horizontal metal frame, having at the top and bottom a close metal mesh with the space between filled with small metal ferrules. Before placing into use the whole cell, easily removable, is dipped in special oil, and allowed to drain. The ferrules are, therefore, coated with a thin oil film representing a very large total area with which the much divided air stream is brought into intimate contact. Under these circumstances, practically every trace of dust is removed.

For lighter work, that is with less dust formation, the somewhat similar "G" type, self-contained dust collector is available having, instead of the centrifugal separator, a simple baffle chamber, the latter being sufficient to separate most of the dust, so that the oil-film cell does not require cleaning at too frequent intervals.

For abnormally high dust concentration also a new type of collector, the "Cyclocell," has now been introduced, with a cylindrical casing having a tangential inlet, and as with the other units, an oil-film filter.



One of the latest machines to be added to the huge plant at the Ward End factory of Wolseley Motors, Ltd., is a large Gridley automatic turning machine. Differential pinion blanks are turned out by this machine from the rough bar in one operation at the rate of one every 40 seconds.

The Canadian Mineral Industry in 1937

A new booklet with the above title has been published which gives brief reviews of sources and output figures of each of the chief metals produced in the Dominion. Similar information is given for industrial minerals, natural gas, petroleum, fuels and other mineral products. Charts are provided for several of the leading minerals, showing long-term production and price trends.

The booklet runs to 100 pages, and may be obtained from the Department of Mines and Resources, Ottawa, Canada, for 25 cents per copy.

Wire Rope Stress Limits

By Richard Saxton

The limits of stress in wire rope and the defects liable to be set up by exceeding that stress in normal usage, are briefly discussed.

THOUGH wire ropes are in general employed chiefly for haulage and hoisting purposes, they find a wide use in many branches of engineering, and whilst safe with reasonable usage, a knowledge of the limits of stress and defects liable to be set up by exceeding that stress cannot fail to be of service to any engineer in charge of operations necessitating the employment of these units.

Limit of stress—i.e., elastic limit of rope metal—is approximately 50% of breaking strain, and whilst the latter, as furnished by the producer, may appear fairly safe in comparison with the load proposed to hoist, it does not infer that the rope may be stressed to near that figure without detriment. In all hoisting or haulage operations there are stresses to be considered other than those of the actual load, and which, unless checked or alleviated, can impart in the aggregate a stress far exceeding the elastic limit.

Apart from raising and lowering, stresses induced are as follows :—Forces due to acceleration of load (kinetic forces). Force equivalent to stress produced by rope bending over pulley. Weight of load ; equipment ; and weight of rope from load to pulley. Stress induced by sudden starting or stopping.

Briefly, total stress is made up of several factors. Including weight of equipment in dead load further stresses are the compressive, induced when rope is passing round pulley or drum, and what is known as the stopping or starting stress, which by careless operating can be so high as to exceed that of the actual load. Where breaking stress of rope is known (generally 10% below that of the aggregate units), it is good practice to divide by 6 and hoist no weights over that figure, as beyond, with the addition of stresses previously enumerated, there is danger of exceeding the elastic limit, a condition of permanent stretch making the hoisting of the lightest load a danger.

In all hoisting systems rope and dead load are part of a complex dynamical system, and due to rope elasticity this system is liable to oscillation in various ways. On the one hand, there may be longitudinal oscillations between pulley and cage, or alternatively transverse oscillations between pulley and drum. Longitudinal oscillations are chief cause of "fatigue stress," a brittle condition of metal structure leading ultimately to fracture. In all cases of longitudinal oscillation maximum stress is imparted at point of arrestment—i.e., point nearest the load,—constant repetition of stress leading to a structural change in rope metal highly detrimental to service life.

Stress, as induced by above oscillations, acts first on the internal units, causing fracture at point of contact between two strands without severance of outer wires. Each stress corresponds to a twisting and un-twisting action, effect of which is to alternately tighten and loosen strands. With each bend and stretch of the rope the units move, movement during bending being from compression to tension zone, but with no return movement where fracture of wires has occurred. Resultant effect of this one-way movement is that fractured units are gradually pushed through the outer or surface wires in the form of loops. In general, these work out at some point well away from the gap caused by fracture, this latter always being found in the compressive zone, and the loops in the tension zone of the cross-section of rope.

Compression stresses, imparted by travel over pulley are a frequent source of rapid wear, as rope during passage is compelled to assume arch or oval form with consequent heavy wear of crown wires in contact with groove. Research on this problem indicates that resistance to bend stress varies inversely with diameter of pulley, arch of curvature increasing with diameter of latter. Excessive wear is due chiefly to inefficient contact of rope and pulley, and to obviate this condition at least one-third of rope circumference should come into contact with pulley face. Free entry and exit of groove should at all times be the rule, as if pinched or crushed additional stress is imparted to bend stress to which subjected.

As previously stated, resistance to bending varies inversely with diameter of pulley, and, where rope fabrication is of numerous fine wires, the greater number of surfaces in frictional contact increase the load resistance. Under normal working conditions, resistance to bending is approximately 1·5% of the power transmitted by rope, and only when diameter of pulley is so small as to produce acute curvature does it exceed 2%. Stress due to external or internal friction during service is unavoidable, as it is due to essential contact with pulley or drum. This, however, can be increased by inefficient or careless working, such as permitting lateral deviation of rope across drum, thus generating excessive angular friction.

As majority of lifting ropes employed in mining are of the strand or Lang's lay type, a description of the difference in fabrication may be of interest. In the strand type the strands are twisted or laid in the opposite direction to the units, this formation ensuring a compact rope, but with the disadvantage that length of wire exposed to pulley face is short. In the Lang's lay fabrication wires and strands are twisted in the same direction, this formation furnishing longer length of wire to meet surface wear.

One detriment to wider employment of ropes of the strand type is that due to method of construction crown wires are exposed to full frictional wear, with consequent deterioration leading eventually to removal from service. Construction as the Lang's lay formation distributes wear over larger area, whilst longer length being more free to adjust itself on the outside of the rope, tendency to rapid wear is minimised. A further advantage imparted by the Lang's lay construction is that torsion of wires and strand work in unison when passing over pulley, whilst in the strand formation they work in opposition. The Lang's lay formation is unsuitable for service on cranes where load is carried on a single pulley or for use with combination blocks, but furnishes efficient service where employed with one end fixed and the other winding on drum.

Greatest flexibility in strand ropes is attained by the substitution of hemp cores for the core wire in each strand, or by reducing diameter and increasing number of unit wires. Latter construction furnishes highest tensile stress, and where this is the primary essential is undoubtedly the best. Where tensile of hemp core construction furnishes a fair margin of safety, construction with component wires of larger diameter than wire of the core type presents greater wearing surface and proportional increase of service life.

The problem of broken wires in a winding rope is one demanding immediate attention, for direct tension is usually the predominant stress, that of bending being less important. Fractured wires in a rope of this description are serious, for if fracture has been caused by tension, practically all units in the same area have been subject to the same stress, with possible weakening of whole cross-section.

Aluminium as a Surface Protection for Steel

THE use of aluminium as a protective medium for steel is increasing. As a protection against corrosion there are four main processes by which the aluminium is applied to steel—viz., by aluminising or spraying, plating the steel with aluminium by rolling, hot-dip plating and calorising. These processes are discussed by Hoff* who gives much useful information; particular attention here, however, is directed to his views on the rolling-on and hot-dipping process, as practised in Germany.

At the present time extensive use is made in Germany of the rolling-on process of plating steel with aluminium, and considerable quantities of strip steel for a variety of purposes are treated by this method. In view of the softness of the aluminium, it is impossible to start the rolling with the steel strip of a considerable thickness, and it is necessary to apply the aluminium in the form of foil directly to the rolled strip. Two processes are used, namely, the hot-plating at a temperature of 300° to 400° C., and the cold-plating process which is carried out at room temperature. Hot-plating has the advantage that the adhesion of the aluminium to the steel can be obtained by using a comparatively low rolling pressure while, on the other hand, cold-plating does away with the expense of having a furnace for the preheating of the steel.

If the plated material is required for deep-drawing purposes, it must be soft-annealed after rolling. This annealing caused considerable difficulties in view of the fact that aluminium will readily combine with the steel at temperatures of 500° to 600° C. with the formation of the compound $FeAl_3$. It was, therefore, necessary to develop a steel composition with a recrystallisation temperature as low as possible and whidh would start reacting with the aluminium at as high a temperature as possible. Some help in developing such material was obtained from experiments on the plating of basic Bessemer steel, as this steel was found to react with aluminium only at 600° C., as compared with the open-hearth steel which begins to react at 490° to 500° C. It was then further observed that the setting-in of the reaction between steel and aluminium could be shifted to higher temperatures by certain additions to the steel. Additions of silicon were particularly effective in this respect.

In view of the fact that basic steel does not possess sufficiently good deep-drawing properties, it was found necessary to develop a similar non-reactive open-hearth steel. This problem was successfully solved, the temperature of the setting-in of the reaction in the case of particularly soft steel being raised from 500° to 570° C., this upper temperature being sufficiently high to completely soft-anneal a strongly cold-rolled strip steel for all deep-drawing purposes. The relevant patent specification shows that this property of the steel is obtained by increasing its oxygen and nitrogen contents. This, therefore, enabled the production of aluminium-plated strip steel without the formation of the brittle and undesirable intermediate layer of $FeAl_3$.

The discussion of the methods of hot-dip plating aluminium on to steel include the Dellgren, Fink, and Rodriguez processes. The disadvantage of the hot-dip plating process, as compared with the rolling-on process of plating consists chiefly in the fact that in the hot-dip process the formation of the deleterious $FeAl_3$ intermediate layer cannot be avoided owing to the instantaneous reaction of the molten aluminium with the steel. On the other hand, the process has the advantage that it is not necessary to use aluminium foil, and it is also possible to plate shaped parts.

Reference is made to the calorising process in which a mixture of aluminium powder with ammonium chloride and alumina is used, and the parts are brought into contact with this mixture in slowly-rotating drums at temperatures of 850° to 900° C. in a hydrogen atmosphere or completely embedded in the mixture in iron boxes. Reference is also made to the process which does not require the use of a hydrogen atmosphere and which, instead of the aluminium powder, uses a powdered aluminium-iron alloy (40 to 50% Fe). The cleaned metal parts are packed into the mixture in well-closed iron containers, and heated to 900° to 1,000° C. This causes a gradual diffusion of the aluminium into the surface of the parts, resulting in the formation of a layer of $FeAl_3$ covered by an extremely thin layer of metallic aluminium. Further heating causes this aluminium to penetrate into the steel, the surface thereby losing its silvery-white colour, and taking on a dull grey coloration. One cannot, therefore, strictly refer to an aluminium coating in this case, the coating actually consisting of an alumiuium-iron compound.

The efficient protection of iron by aluminium depends on the fact that aluminium is oxidised by air much more slowly than such metals as tin, zinc and lead. This has been confirmed by a number of long-time atmospheric exposure tests in which the behaviour of aluminium, tin, zinc and lead plated steel-sheet specimens was compared. Contrary to zinc, aluminium does not protect the underlying material at exposed parts. In its applications aluminium-coated steel has found widespread use in the packaging industry, while aluminium-plated tubes have replaced lead as a covering for cables. The application of aluminium-plated plate for cans is now quite feasible, except with alkaline materials, as it has been found possible to substitute the usual soldered joint used in tin cans by an efficient flanged joint.

* H. Hoff. *Stahl und Eisen*, 1938, LVIII, 21, pp. 565-568

BRITISH FIRM, sole importers Copper Beryllium Alloy, desires get in touch with first-class metal firms with view to importing product at greatly reduced price. References exchanged. Reply Box No. 97.

THE PROPRIETORS of the BRITISH PATENTS Nos. 409910 (Process for Refining Crude Copper); 409911 (Process for the deoxidation and purification of Copper); 430526 (Process for the deoxidation and purification of Copper) and 430869 (Process for the deoxidation and purification of Copper), are prepared to enter into negotiations for the SALE of the patents or for the grant of LICENCES thereunder. Any enquiries to be addressed to **CARPMAELS & RANSFORD, 24, Southampton Buildings, LONDON, W.C. 2.**

THE PROPRIETORS OF THE BRITISH PATENTS Nos. 404300 (Process for deoxidizing steel); 405456 Improvements in the manufacture of steel); 405633 (A Process for the dephosphorising of steel); 423048 (Improvements in the manufacture of iron alloys of very low carbon content); 423732 (Improvements in or relating to acid slags for deoxidising steel); 427466 (Process for the manufacture of steel); 427763 (Improvements in or relating to the dephosphorisation of steel); 431329 (Improvements in or relating to the manufacture of iron alloys); 432439 (Process for purifying nickel); 436450 (Improvements in or relating to the treatment of metals with slags); 450237 (Improvements in or relating to the manufacture of steel); 455042 (A process for dephosphorising and desulphurising steel); 455070 (Process for the desulphurisation or simultaneous desulphurisation and dephosphorisation of steel); and 457856 (Process for the deoxidation of ferrous metals with cyclic utilisation and regeneration of slags), are prepared to enter into negotiations for the SALE of the patents, or for the grant of LICENCES thereunder. Any inquiries to be addressed to **CARPMAELS & RANSFORD, 24, Southampton Buildings, LONDON, W.C. 2.**

Business Notes and News

Developments in Light Metal Alloy Manufacture

In January, 1937, Imperial Chemical Industries, Ltd., announced its entry, through its subsidiary I.C.I. Metals, Ltd., into the light metal alloy industry as a manufacturer of strip and sheet to the various D.T.D. and British Standard specifications. Since then the company's interest in this field has become such that it has been decided to embark at once upon a major scheme of development. This will involve the installation of extensive new equipment at the company's works at Witton, near Birmingham, and will consolidate the leading position which I.C.I. holds in the non-ferrous metal industry of the United Kingdom.

New Steelworks for Jarrow

At the recent annual general meeting of the Consett Iron Co. Ltd., Mr. Clive Cookson, chairman, announced that arrangements were being completed for taking over the site for a new steelworks at Jarrow, and for forming a new company, the Consett company providing £200,000 of the capital. The site has now been taken over, and the Bankers Industrial Development Co., together with the Consett Iron Co., have registered the new company as the New Jarrow Steel Co. The nominal capital is £700,000 in £1 shares in 200,000 6% "A" Preferred, 200,000 6% "B" Preferred, and 300,000 Deferred.

The subscribers are: Mr. Clive Cookson, lead manufacturer; Mr. Edward J. George (general manager, Consett Iron Co.); Mr. Ralph Alsop (assistant general manager and secretary, Consett Iron Co.); Sir Chas. Bruce Gardner, and Mr. Duncan Alexander Stirling, merchant banker. The board of the new company will be limited to nine. The registered office is at Consett Iron Works, Consett, Durham.

Vickers' Interm Dividends

The directors of Vickers, Ltd., give notice that the following interim dividends for the half-year ended June 30, 1938, will be paid to the holders of the preferred 5% stock, the 5% preference stock, and the cumulative preference stock of the company who are registered in the books of the company on Tuesday August 2, 1938:—

2½%, less income tax, on the preferred 5% stock.
2½%, less income tax, on the 5% preference stock.
2½%, free of income tax, on the cumulative preference stock.

Payment will be made on Friday, August 26, 1938. The registers of members relating to these issues will be closed from Wednesday, August 3, to Saturday, August 13, 1938, inclusive.

Non-Destructive Testing of Materials

The Joint Committee on Materials and Their Testing are organising a meeting to be held on November 25 next, for the discussion of the subject of non-destructive testing. The meeting will be held under the auspices of the Institution of Electrical Engineers, and will be under the presidency of Dr. A. P. M. Fleming, president of the Institution. For convenience, the subject has been divided into three sections, namely, magnetic and electrical methods, X and Gamma-rays, acoustical and general methods, and each section will be dealt with by authors representing, respectively, Great Britain, the Continent of Europe and the United States.

Magnetic and electrical methods will be dealt with in papers by Dr. B. Berthold, director of the Reichs-Rontgenstelle, Berlin, and by Dr. A. P. M. Fleming and Mr. B. G. Churcher; X and Gamma-rays will be dealt with by Ing. J. E. de Graaf, of Philips Gloeilampenfabrieken, Holland, and Dr. V. E. Pullin, acoustical and general methods will be dealt with by Professor Dr. Koster, of the Kaiser-Wilhelm-Institut fur Metallforschung, Stuttgart, and Dr. S. F. Dorey, of Lloyd's Register. The experience and views of the United States of America will be presented in a joint paper by Mr. N. L. Mochel, metallurgical engineer, Westinghouse Electric and Manufacturing Co., Philadelphia; Mr. H. H. Lester, senior physicist, Watertown Arsenal, Watertown, Massachusetts; and Mr. R. L. Sanford, chief of the Magnetic Section, National Bureau of Standards, Washington, D.C.

British Industries Fair

The British Industries Fair of 1939 will be held in London and Birmingham from February 20 until March 3. It is noteworthy that since the Fair held in 1915 the amount of exhibiting space occupied in London alone has increased from 88,000 sq. ft. to 550,000 sq. ft. These figures illustrate the value and importance that manfacturers attach to exhibiting at the Fair. There is every indication that the demand for space will again exceed the area available, and the importance of making an immediate application for space is therefore emphasised. To avoid any misunderstanding, interested firms are reminded that it is essential, even if they have already notified the Department of Overseas Trade provisionally of their intention to exhibit, they should fill in and send the requisite form of application in confirmation of their requirements.

New Rolling Mill Plant for Whitehead Iron and Steel Co.

An important contract has just been obtained by Metropolitan-Vickers Electrical Co., Ltd., for the complete electrical equipment for the new cold-rolling plant to be installed by Messrs. Whitehead Iron and Steel Co., Ltd., at their Courtybella Works, Newport, Monmouth. The contract which includes a total of over 6,000 h.p. of machines comprises the main and auxiliary drives for a four-stand, four-high tandem cold strip mill, and for two single-stand, four-high cold strip mills, complete with motor generator sets and switch and control gear.

The tandem cold strip mill can be operated either as a three- or four-stand mill, being equipped with two motor-driven coiling reels, one between the third and fourth stand for use when operating as a three-stand mill, and the other following the four stand for use when operating as a four-stand mill. Each of the single-stand mills is also equipped with a separate motor-driven reel, and the equipment is specially designed to maintain constant tension in the strip between the reel and the mill over a wide range of speed and tension requirements.

Rise in Price of Copper

The American copper market has recently experienced a striking revival, and the price of standard copper has risen more than 10% inside a month. The lull following heavy buying has not been so long as was expected, and sales have again risen. It is generally recognised that the increased buying is not so much concerned with immediate consumption to meet present orders, but representing a restocking movement in anticipation of higher prices. It is believed that consumption has, in fact, touched bottom, and that the higher price does represent a real change in the industry's prospects.

The London market is discounting each American price increase in advance, and is thus keeping ahead of the American market. This is encouraging American exports, and last month they were up to 9,300 long tons. With the recent quota cut in force, by which now American production is reduced by about 5,400 long tons per month, and consumption of the latter maintained at the June level, the United States could export 9,000 tons of copper per month without there being any net addition to non-American stocks.

I.C.I. Research Manager Retires

Major F. A. Freeth, O.B.E., D.Sc., Ph.D., F.R.S., who has been research manager of Imperial Chemical Industries since the formation of the company in 1926, is retiring from that position, but has consented to continue his connection with the company in the capacity of consultant.

Major Freeth, who comes of a military family, was educated at Liverpool University, and at an early age gained considerable reputation as a physical chemist, becoming chief chemist to Messrs. Brunner Mond and Co., Ltd., in 1910.

On the outbreak of the Great War he went to France with the Cheshire Regiment, but was recalled to England to undertake scientific work in connection with the supply of munitions. He rejoined Messrs. Brunner Mond, and for the remainder of the war he did very valuable work in developing new processes for the manufacture of explosives. For his services to the country he was honoured with the O.B.E. In 1924 Major Freeth was awarded the doctorate in the Faculty of Mathematics and Physics in the University of Leyden. He was elected a Fellow of the Royal Society at the early age of 41.

Effect of Carbon on the Critical Cooling Rate of High-purity Iron-carbon Alloys and Plain Carbon Steels

THE composition and grain size of austenite are now recognised as factors that influence the critical cooling rate of harden ability of steel. Arecent report* by Thomas C. Digges, describes some experiments made on a series of high-purity iron-carbon alloys and two series of plain carbon steels to determine the influence of carbon on the critical cooling rate of these materials.

The high-purity iron-carbon alloys were prepared from hot- and cold-worked specimens of a heat of vacuum-fused electrolytic iron by carburising in a hydrogen-benzene mixture. The carburised specimens were heated and cooled *in vacuo* to obtain uniform distribution of the carbon. Cooling during this homogenizing treatment was sufficiently rapid to form sorbite (or fine pearlite) in all of the alloys. Microscopic examination of the cross-sections of the bars of the different alloys showed the carbon to be uniformly distributed. The alloys studied contained 0·23, 0·40, 0·50, 0·62, 0·73, 0·80, 0·85, 1·01, 1·14, and 1·21% of carbon, respectively. These values are believed to be accurate within the limits of plus or minus 0·01% of carbon.

The series of plain carbon steels was also prepared by pack-carburising specimens of a 0·20% carbon steel followed by pack-annealing and normalising. A second series of plain carbon steels was prepared by carburising specimens of the same 0·20% carbon steel in hydrogen and benzene and homogenizing by heating and cooling *in vacuo*. The plain carbon steels varied in carbon from that of the basic material, 0·20 to 1·38%. These steels also contained about 0·46% of manganese and 0·15% of silicon.

Spectrochemical and chemical analyses, as well as determinations of gas content by a vacuum-fusion method, showed that sulphur, nickel, cobalt, and oxygen were the major impurities in the iron-carbon alloys. The total of all the impurities determined was about 0·030%. Abnormal structures were produced in the hypereutectoid alloys annealed *in vacuo* at 1,700° F. All specimens used for determination of the austenitic grain size and critical cooling rate had an initial structure of sorbite (fine pearlite).

Austenitic grain size was determined for the highest-carbon alloy (1·21% of carbon) at a temperature sufficiently high to insure complete solution of all the carbon. Subsequent determinations on the lower-carbon alloys showed that variations in carbon did not affect the grain size at this selected temperature of 1,700° F. Each of the alloys at 1,700° F. had an average grain size of six to 12 grains per sq. in. at 100 diameters (A S T M grain number four).

The carbon steel containing 1·18% of carbon had the same grain size as the alloys at 1,700° F. Lower temperatures were necessary to establish the same austenitic grain size in the lower-carbon steels. On heating within the recommended hardening temperature range, specimens of the hypoeutectoid carbon steels had a constant average grain size of 12 to 24 grains per sq. in. at 100 diameters (A S T M grain number five). No differences were observed in temperature-grain-size-critical-cooling relations of the carbon steels prepared by pack-carburising and those carburised in hydrocarbon.

The critical cooling rate was taken as the average cooling rate, between 1,110 and 930° F., which produced in the quenched specimen a structure of martensite with nodular troosite (fine pearlite) in amounts estimated to be between 1 and 3%. The critical cooling rate was determined for each of the iron-carbon alloys quenched directly from 1,700° F., and for the carbon steels varying in carbon from 0·43 to 1·18%, quenched also from the temperatures establishing a constant austenitic grain size with all carbon in solution.

For the selected conditions of constant austenitic grain size and solution of all carbon in the austenite, the critical cooling rate decreased continuously with increase in carbon, for both the high-purity iron-carbon alloys and plain carbon steels. That is, the hypereutectoid alloys had slower critical cooling rates (were deeper hardening) than the alloys of eutectoid and hypoeutectoid compositions, and the hypereutectoid steels were deeper hardening than the steels of eutectoid and hypoeutectoid compositions. However, a small change in the carbon content of the austenite of the lower-carbon alloys and steels had a more marked effect on the critical cooling rate than did a corresponding change in carbon of the high-carbon alloys and steels.

The carbon content of the austenite, therefore, had a pronounced influence on the hardenability of the alloys and steels. Under similar conditions with respect to austenitic grain size, carbon content, and with complete solution of the carbon in the austenite, the high-purity iron-carbon alloys hardened less deeply than did the plain carbon steels. This difference in hardenability was due principally to difference in manganese content of the alloys and steels.

For the carbon steels quenched from the usually-recommended hardening temperature, the critical cooling rate decreased with increase in carbon up to about 0·75 to 0·80%, but increased rapidly with further increase in carbon up to about 1·05%. Changes in carbon from about 1·05 to 1·40% had no appreciable influence on critical cooling rate. These critical cooling rates, however, were influenced by variations in austenitic grain size, and carbon content of austenite as well as the total carbon content. Full depth of hardening was obtained only when all the carbon was in solution in the austenite.

* *Jour. of Research*, U.S. Bureau of Standards, vol. 20. May, 1938 Research Paper 1,092. Obtainable from Superintendent of Documents, Washington, D.C., price 10 cents.

Catalogues and other Publications

A book of tables and data relative to the use of steel in reinforced concrete construction has been published by Isteg Steel Products Ltd., whose product, Isteg steel, consists of two round mild steel bars twisted together and uniformly stretched up to the normal yield point during manufacture; this cold working increasing the yield point so that it is possible to impose on an Isteg bar a stress of 27,000 lb. per sq. inch.

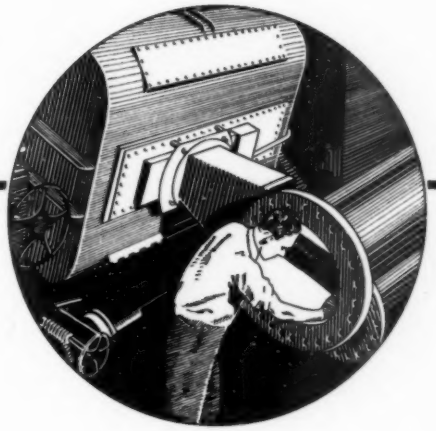
By the use of a table of equivalents, a design based on the well-known standard formulæ relating to plain bar can be converted to suit the Isteg steel sections. The book gives such tables, also fifteen tables of weights, perimeters, sectional areas, bending moments and limiting spans. In some cases the tables are amplified by the addition of useful diagrams and there are twenty fully worked examples, also with diagrams. One very useful table is that for the design and reinforcement of column bases, for safe earth pressures of 1 to 4 tons/sq. ft., for bases from 3 ft. square to 15 ft. square, and weights from 9 to 900 tons. This table and data book is obtainable from Isteg Steel Products Ltd., at 8, Duncannon Street, Charing Cross, London, W.C. 2.

Steel forgings are dealt with in an informative manner, in a well illustrated book published by Steel, Peech and Tozer, the Ickles, Sheffield. The brief foreword shows how every heavy steel forging must be regarded as a special job, then the text continues in logical sequence to describe how a heavy forging is "planned," from the first consideration of such factors as direction and magnitude of service stresses, special requirements in regard to resistance to wear and abrasion, strength, toughness and capacity to resist shock, and the surfaces which may require finish machining; thence through the various stages of ingot, forging—hammer forge and hydraulic press action being described—refinement of grain in the forging process, heat-treatment, tests, types of forgings made, and machining and inspection.

The sizes of ingot available are detailed in a separate publication (SPT. 154A), and the book is completed by a table of the classes of steel available for forgings, this table classifying carbon steels, nickel steels and various alloy steels with their chemical analysis and mechanical properties in specified states.

This well produced, well illustrated publication has reference SPT. 217 and is an informative addition to the literature available for steel workers and users.

How to be SURE of Quality



IN many applications, neither the foundry nor its customers can afford to take chances with quality. A single fault in the internal structure of the metal may render an expensive casting unfit for the particular use for which it was designed.

A dependable and economical method of finding such flaws before they can do any damage is examination by x-ray. And of primary importance is the fact that the finding of a flaw in a large casting is not necessarily a signal for the discard, because the x-ray film that shows the fault is also an accurate guide to repair by welding—a practice followed profitably by many users of industrial x-ray apparatus. Here, then, is a sound reason for employing this modern method of non-destructive testing—by guiding good repair, it can actually save castings, and in some cases save the time and money expended in machining that would ultimately disclose the flaw.

Furthermore, if x-ray examination shows similar faults in the same relative positions in several castings, you have good evidence that an improvement in foundry technique is needed. And many experienced users of x-ray equipment have pointed to the value of x-ray in guiding improvements in foundry methods—improvements that have resulted in as much as doubling the yield from a single melt, and cutting almost to nothing the cost of replacing defective castings produced by techniques not quite up to standard. On pilot castings or on production pieces, x-ray provides information that can be obtained in no other way—information that may enable you to save time and money because it will tell you where and how to achieve better methods.

There you have the story of why many progressive foundries are turning to x-ray for complete examination of certain important castings, and why they are using x-ray routinely in the development of better foundry techniques to assure better quality to their customers.

Why not take advantage now of the services of experienced x-ray engineers to help you apply x-ray profitably in your plant; and you will probably be surprised to find what a modest investment would be required to enable you to enjoy its benefits. Your request for help and information implies no obligation. Just address Dept. LV.

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MARKET PRICES

ALUMINIUM.

98/99% Purity		£100	0	0

ANTIMONY.

English		£70	10	0
Chinese		48	0	0
Crude		30	0	0

BRASS.

Solid Drawn Tubes	lb.	0	0	11½
Brazed Tubes	„	0	1	1½
Rods Drawn	„	0	0	9½
Wire	„	0	0	8½
*Extruded Brass Bars	„	0	0	5

COPPER.

Standard Cash		£41	7	6
Electrolytic		47	10	0
Best Selected		46	10	0
Tough		42	5	0
Sheets		78	0	0
Wire Bars		47	15	0
Ingot Bars		47	15	0
Solid Drawn Tubes	lb.	0	1	0½
Brazed Tubes	„	0	1	0½

FERRO ALLOYS.

‡Tungsten Metal ° Powder. nominal	lb.	£0	4	9½
‡Ferro Tungsten ° nominal	„	0	4	8
Ferro Molybdenum °				
Ferro Chrome, 60-70% Chr. Basis 60% Chr. 2-ton lots or up.				
NOMINAL 2–4% Carbon, scale 12/– per unit	ton	34	15	0
NOMINAL 4–6% Carbon, scale 8/– per unit	„	24	5	0
NOMINAL 6–8% Carbon, scale 7/6 per unit	„	24	0	0
NOMINAL 8–10% Carbon, scale 7/6 per unit	„	24	0	0
§Ferro Chrome, Specially Refined, broken in small pieces for Crucible Steelwork. Quantities of 1 ton or over. Basis 60% Ch. Guar. max. 2% Carbon, scale 12/6 per unit	„	37	0	0
Guar. max. 1% Carbon. scale 13/– per unit	„	39	0	0
§Guar. max. 0.5% Carbon, scale 13/– per unit	„	49	0	0
‡Manganese Metal 97–98% Mn	lb.	0	1	3
‡Metallic Chromium	„	0	2	5
§Ferro-Vanadium 25–50%	„	0	14	0
§Spiegel, 18–20%	ton	11	0	0
Ferro Silicon—				
Basis 10%, scale 3/– per unit nominal	ton	10	5	0
20/30% basis 25%, scale 3/6 per unit	„	12	0	0
45/50% basis 45%, scale 5/– per unit	„	12	10	0
70/80% basis 75%, scale 7/– per unit	„	17	0	0
90/95% basis 90%, scale 10/– per unit	„	30	0	0
§Silico Manganese 65/75% Mn., basis 65% Mn.	„	18	15	0
§Ferro - Carbon Titanium, 15/18% Ti	lb.	0	0	4½
Ferro Phosphorus, 20–25%	ton	22	0	0
§Ferro-Molybdenum, Molyte	lb.	0	4	9
§Calcium Molybdate	„	0	4	5

FUELS.

Foundry Coke—				
S. Wales	—	2	0	0
Scotland	—	1	15	0
Durham	—	1	14	6
Furnace Coke—				
Scotland		1	10	0
S. Wales	—	1	9	0
Durham	—	1	7	6

GUN METAL.

*Admiralty Gunmetal Ingots (88 : 10 : 2)		£64	0	0
*Commercial Ingots		48	0	0
*Gunmetal Bars, Tank brand, 1 in. dia. and upwards	lb.	0	0	11
*Cored Bars	„	0	1	1

MANUFACTURED IRON.

Scotland—				
Crown Bars,		£13	10	0
N.E. Coast—				
Rivets		12	15	0
Best Bars		15	15	0
Common Bars		12	10	0
Lancashire—				
Crown Bars		13	10	0
Hoops		14	2	6
Midlands—				
Crown Bars		13	10	0
Marked Bars		15	15	0
Unmarked Bars			—	
Nut and Bolt Bars		11	15	0
Gas Strip		14	2	6
S. Yorks.—				
Best Bars		15	15	0
Hoops		14	2	6

PHOSPHOR BRONZE.

*Bars, "Tank" brand, 1 in. dia. and upwards—Solid	lb.	£0	0	11
*Cored Bars	„	0	1	1
†Strip	„	0	0	10½
†Sheet to 10 W.G.	„	0	0	11
†Wire	„	0	1	0½
†Rods	„	0	1	0
†Tubes	„	0	1	6½
†Castings	„	0	1	3

†10% Phos. Cop. £33 above B.S.
†15% Phos. Cop. £38 above B.S.
†Phos. Tin (5%) £32 above English Ingots.

PIG IRON.

Scotland—				
Hæmatite M/Nos.		£6	13	0
Foundry No. 1		6	0	6
„ No. 3		5	18	0
N.E. Coast—				
Hæmatite No. 1		6	13	0
Foundry No. 1		5	11	6
„ No. 3		5	9	0
„ No. 4		5	8	0
Silicon Iron			—	
Forge		5	8	0
Midlands—				
N. Staffs. Forge No. 4		5	8	0
„ Foundry No. 3		5	11	0
Northants—				
Foundry No. 1		5	11	6
Forge No. 4		5	5	6
Foundry No. 3		5	8	6
Derbyshire Forge		5	10	0
„ Foundry No. 1		5	14	0
„ Foundry No. 3		5	11	0
West Coast Hæmatite		7	4	8
East „ „		7	3	6

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Per English ton £19 12 2/£21 4 9

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„ Brazery		30	0	0
„ Wire			—	
Brass		23	0	0
Gun Metal		33	0	0
Zinc		8	0	0
Aluminium Cuttings		71	0	0
Lead		13	10	0
Heavy Steel—				
S. Wales		3	10	0
Scotland		3	6	0
Cleveland		3	7	0
Cast Iron—				
Midlands		3	5	0
S. Wales		3	10	0
Cleveland		3	15	0
Steel Turnings—				
Cleveland		2	12	6
Midlands		2	5	0
Cast Iron Borings—				
Cleveland			—	
Scotland		2	2	6

SPELTER.

G.O.B. Official			—	
Hard		£9	0	0
English		15	2	6
India		12	5	0
Re-melted		10	0	0

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„ „ (Land), N.E.Coast		12	0	0
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Hard Basic £6 17 6 to		10	2	6
Medium Basic, £6 12 6 and		10	0	0
Soft Basic		8	15	0
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Manchester Hoops		11	5	0
Scotland, Sheets 24 B.G.		15	15	0

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Finished Bars 14% Tungsten	lb.	£0	3	0
Finished Bars 18% Tungsten	„	0	3	10
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Round and Squares, ¼ in. to ½ in.	„	0	0	3
Under ½ in. to ⅞ in.	„	0	1	0
Round and Squares, 3 in.	„	0	0	4
Flats under 1 in. × ⅛ in.	„	0	0	3
„ „ ⅛ in. × ½ in.	„	0	1	0

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Standard Cash		£193	15	0
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Australian			—	
Eastern		198	0	0
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Rods		19	10	0
Battery Plates			—	
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§ Prices ex warehouse, Aug. 8.
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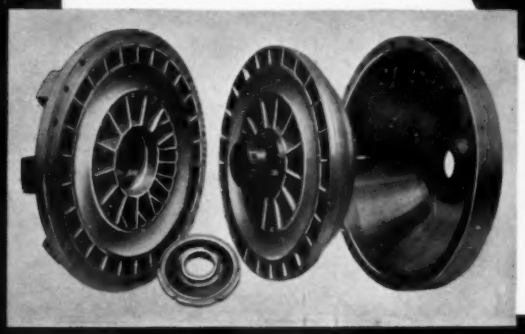

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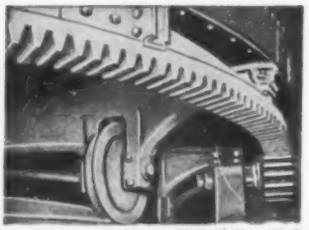

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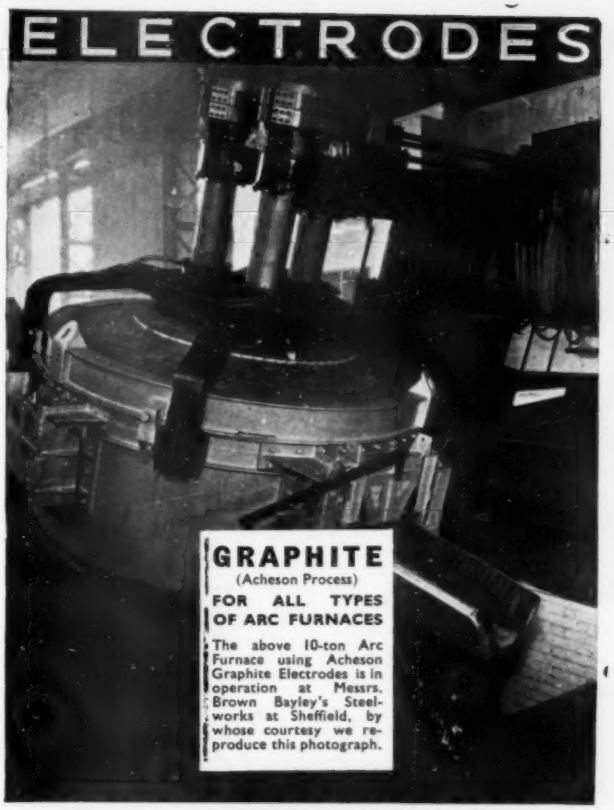
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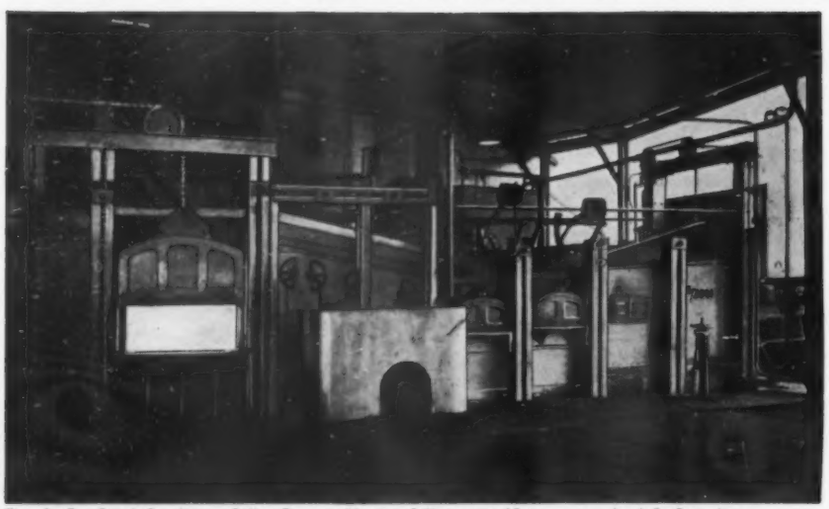

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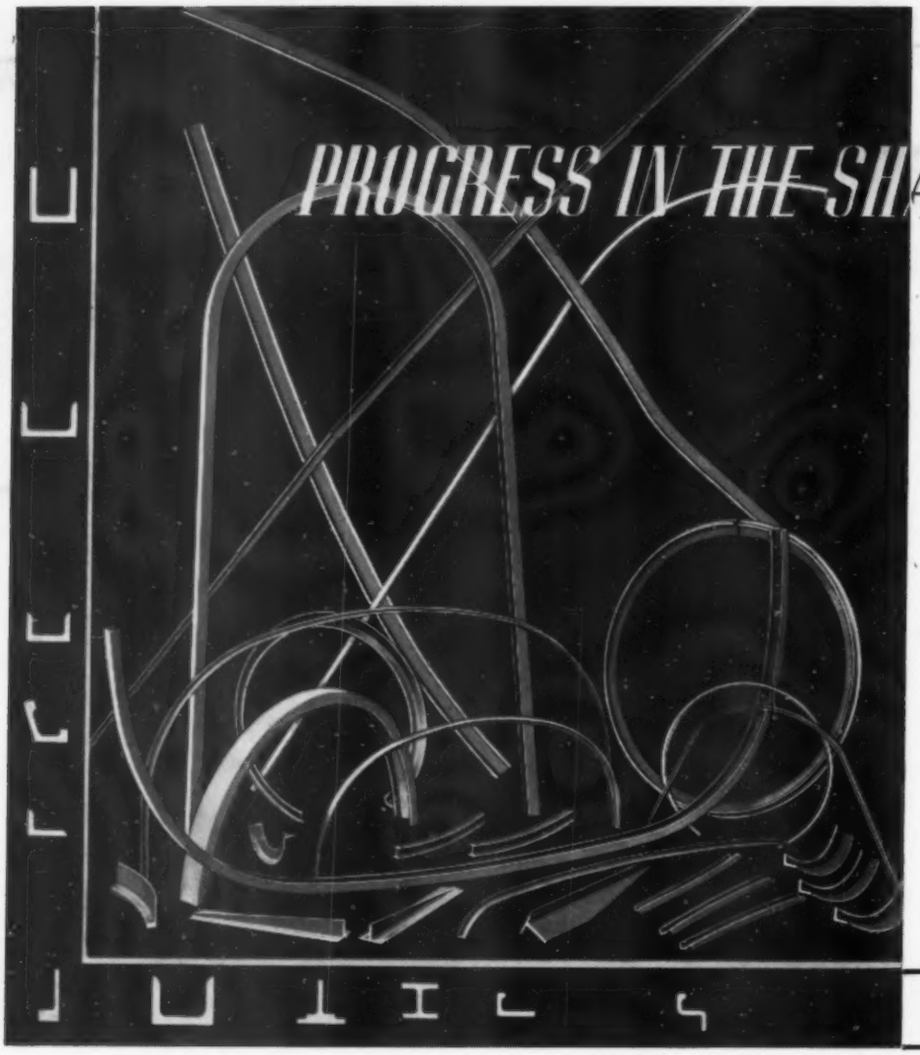

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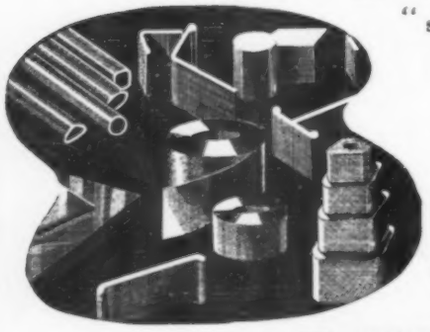

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